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RESEARCH MEMORANDUM

By authority of H L Dryden per NACA release Arm 1373 - 9/11/53 Date 1/22/53

for the

Bureau of Aeronautics, Navy Department

TANK TESTS OF A 1/7-SIZE POWERED DYNAMIC MODEL OF THE GRUMMAN XJR2F-1 AMPHIBIAN.

SPRAY CHARACTERISTICS, TAKE-OFF AND LANDING STABILITY IN SMOOTH WATER - LANGLEY TANK MODEL 212

TED No. NACA 2378

By

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Langley Field, Va.

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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TANK TESTS OF A 1/7-SIZE POWERED DYNAMIC MODEL OF THE GRUMMAN XJR2F-1 AMPHIBIAN.

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SUMMARY

Tests of a model of the XJR2F-1 amphibian were made in Langley tank no. 1 to determine the spray characteristics and the take-off and landing stability.

At a gross load of 22,000 pounds full size, spray entered the propeller disks only at a very narrow range of speeds. The spray striking the flaps was not excessive and no appreciable wetting of the tail surfaces was noted.

The trim limits of stability appeared to be satisfactory and the upper-limit porpoising was not violent. The stable range of center-of-gravity locations with flaps set 20° was well aft of the desired operating range. However, with flaps up, the forward limit was about 18 percent mean aerodynamic chord and the aft limit about 28.5 percent mean aerodynamic chord at a load of 26,000 pounds and with elevators deflected -10°. Under these conditions the location of the step is considered satisfactory. Tests showed that the effect of water in the nose-wheel well would be to move the forward limit aft about 2-percent mean aerodynamic chord.

Without ventilation of the main step, the model skipped during landing at most trims, but this skipping was not violent. With the ventilation, the model skipped lightly only at trims where the afterbody keel was approximately parallel to the water (around 7.5°).

INTRODUCTION

The take-off and landing stability and the spray characteristics of a 1/7-size powered dynamic model of the Grumman XJR2F-1 amphibian have been investigated in Langley tank no. 1. This airplane is designed for air-sea rescue purposes and will operate with a normal gross load of 22,600 pounds. The lines for the hull, furnished by the Grumman Aircraft Engineering Corporation, were developed from results of tests which were made in the towing basin at Stevens Institute of Technology on a 1/17.6-size hull model. (See references 1 and 2.) The tests described in this report were requested by the Bureau of Aeronautics, Navy Department, in their letter of May 7, 1945, Aer-E-23-FAL, and had as their purpose the evaluation of the hydrodynamic characteristics of the final design.

An investigation of the take-off stability was made by determining the limits of stable trims and center-of-gravity locations. In addition, the range of speeds and loads over which spray entered the propellers was determined. Landing behavior was observed with and without the ventilation of the step provided in the manufacturer's design. Also, the effect of water in the nose-wheel compartment was investigated.

Mr. John Heins of the Grumman Aircraft Engineering Corporation witnessed most of the tests.

DESCRIPTION OF THE MODEL

A 1/7-size dynamically similar model of the XJR2F-1 was constructed at the Langley Laboratory, using drawings and dimensions furnished by the Grumman Aircraft Engineering Corporation. The principal dimensions of the model are given in table I. The general arrangement of the model is shown in figure 1, and photographs are presented in figure 2.

Several dimensions of the model were not scale values of the full size. The only propellers available for these tests had a diameter which was 0.5 inche greater than scale diameter. The vertical location of the center of gravity was 1.5 inches above the design position on the model (necessary in order to balance the model at light loads). The horizontal stabilizer was set at an incidence of 4.5° to the base line as shown on the original drawings received from the Grumman Corporation. This setting was 1° higher than the setting adopted later by their design engineers. These departures from the scale values would have only a negligible effect on the test results.

The general construction of the model was similar to that of most dynamic models tested in the Langley tank. (See reference 3.) The hull was built in three parts to facilitate changes in the depth and position of the step. Ventilation ducts from the main wheel wells to the step were provided in the model to simulate the full-size installation. Drain holes for the main wheel wells were also provided in the model.

The model was equipped with a nose-wheel well (dummy wheels inside) and drains. The drains were fitted with small fairings that approximated the shape of those used on the full size.

The power installation consisted of two 2.0-horsepower, three-phase, variable-frequency, electric motors which turned three-blade metal propellers.

Slats were attached to the leading edge of the wing in order to delay the stall to angles more nearly corresponding to the stall expected for the full size.

The pitching moment of inertia of the ballasted model was 5.23 slug-feet^2 at a center-of-gravity location of 25-percent mean aerodynamic chord. This moment of inertia is 12 percent greater than that corresponding to the full size.

APPARATUS AND PROCEDURE

The towing equipment and some of the testing methods used in Langley tank no. 1 are described in reference 4. A description of similar test procedures used for this investigation is presented in reference 3.

Unless otherwise specified, the following conditions were maintained for all of the tests:

Stabilizer, -0.5° to the wing chord

Leading-edge slats on wing

Deflection of elevators -10°

Position of center of gravity, vertical position 16.06 inches above keel at step, horizontal position, 25 percent mean aerodynamic chord

For tests with full power; blade angle 12° at $\frac{3}{4}$ radius rpm, 7100;

Nose-wheel well drains sealed; step vented to interior of hull through wheel well compartments.

The trim was referred to the base line of the model. Moments tending to raise the bow were considered positive.

The effective thrust, which was measured at a trim of 0° with the model towed just clear of the water, was computed from the following expression:

$$T_e = D + R$$

where

T_e effective thrust, pounds

D drag of model without propellers, pounds

R measured resultant horizontal force, power on, pounds

Without power, the aerodynamic lift and pitching moments were measured at a speed of 40 feet per second. With power, the aerodynamic lift and pitching moments were determined for a range of speeds from 0 to 40 feet per second. The aerodynamic lift and pitching moment coefficients, computed from these data, are defined as follows:

$$\text{Lift coefficient,} \quad C_L = \frac{L}{1/2}\rho SV^2$$

$$\text{Pitching-moment coefficient,} \quad C_m = \frac{M}{1/2}\rho SV^2c$$

where

L lift, pounds

M pitching moment, pound-feet (referred to a position of the center of gravity of 25 percent M.A.C.)

ρ density of air, slugs per cubic foot

S area of wing, feet^2

V carriage speed, feet per second (about 95 percent of airspeed)

c mean aerodynamic chord, 1.54 feet

The effects of power, leading-edge slats, and the gap between leading edge of the elevator and the stabilizer on the trim in the air were determined by towing the model free to trim, at a constant speed of 40 feet per second, with the main step just clear of the water.

An investigation of the bow spray was made for a speed range from 0 to 15 feet per second, with full power, flaps 0°, and at gross loads of from 60 to 75 pounds. Photographs of the bow spray were taken at speed increments of 1 foot per second.

The trim limits of stability were determined with flaps deflected 20°, at a gross load of 75 pounds, with and without power. The lower trim limit was obtained with the center of gravity at 22 percent mean aerodynamic chord, and the upper trim limits at 32 percent mean aerodynamic chord. The aerodynamic pitching moments were not great enough to completely determine upper- and lower-trim limits at a single position of the center of gravity.

The limits for stable positions of the center of gravity were determined with full power and at gross loads of 65.2 and 75 pounds, elevator settings of 0°, -10°, and -20°, and flap settings of 0° and 20°. A uniform rate of acceleration of 1 foot per second per second was used for these tests.

The landing stability was determined for a trim range from 3.5° to 12.5°. The landings were made with approximately $\frac{1}{4}$-full thrust, with flaps deflected 45°, and at a gross load of 75 pounds. The variation in trim and rise during landing was recorded.

RESULTS AND DISCUSSION

Aerodynamic tests.- The effective thrust in the take-off range with a propeller blade angle of 12° and an rpm of 7100 is presented in figure 3. The scale thrust from the Grumman estimate for the full size is given for comparison.

Aerodyanmic lift and pitching-moment coefficients, with power off, for flap deflections of 20° and 45° are shown plotted against trim in figures 4 and 5, respectively. Similar data, with full thrust, for flap deflections of 0° and 20° are presented in figures 6 and 7, respectively. The variation of lift with speed, with full thrust, for a flap deflection of 20° is given in figure 8.

The effect of power on the free-to-trim characteristics of the model in the air with the flaps set 20° is shown in figure 9. With full power, a very small change in elevator deflection (2°) was sufficient to change the trim of the model 13°. Figure 10 shows the relatively small effect of leading-edge slats and the elevator-stabilizer gap on the trim in the air.

Spray characteristics.- Representative photographs of the bow spray (figs. 11 and 12) were selected to cover the range of speeds over which the spray entered the propeller disks. The range of speeds over which spray entered the propeller disks is shown in figure 13. At gross loads up to about 65 pounds, light spray entered the propellers over a very narrow range of speeds. At gross loads above 65 pounds, spray in the propellers was blown back over the top of the wing.

The range of speeds over which spray struck the flaps is shown in figure 14. This range was almost the same as that in which the spray entered the propeller disks. The spray striking the flaps was not considered excessive.

The roach from under the afterbody did not excessively wet the tail extension. At planing speeds the spray from under the forebody cleared the horizontal tail and no appreciable wetting of the tail surfaces was noted.

Trim limits of stability.- The trim limits of stability with and without power are shown in figure 15. The range of stable trims between the upper limit, increasing trim, and lower trim limit is about 6.5° with power and about 8° without power. Upper limit porpoising was not violent and recovery from upper limit porpoising could easily be made by use of the elevators.

Center-of-gravity limits for take-off.- The variation of trim with speed with a flap deflection of 20° for several gross loads, elevator deflections, and locations of the center of gravity are shown in figures 16 to 18. The maximum amplitude of porpoising obtained from these data is plotted against the fore-and-aft position of the center of gravity in figure 19. It is apparent from this figure that, for each deflection of the elevators, there is a forward and an after position of the center of gravity beyond which porpoising is encountered. Assuming a maximum allowable amplitude of porpoising of 2°, these limiting positions have been plotted against gross load in figure 20. The discontinuities in the forward limits for elevators deflected -10° and -20° apparently are due to a peculiarity in the hydrodynamic trimming moment characteristics of the hull.

At the design gross load (22,600 pounds full size) and with flaps down 20° lower limit porpoising greater than 2° amplitude was encountered with the center of gravity forward of 28 percent mean aerodynamic chord. (See fig. 20.) This is about 2-percent aft of the most after center-of-gravity location given in the Grumman weight and balance report (reference 5) for this load. With the estimated loading conditions encountered in service, take-offs with flaps deflected 20° would be subject to prohibitive porpoising. In order to permit take-offs with flaps down 20° and the center of gravity at 23 percent mean aerodynamic chord, the forward center-of-gravity limit should be moved forward approximately 5 percent mean aerodynamic chord. The relationship between a step movement and the consequent shift in the forward center-of-gravity limit can be approximately expressed by the following equation:

$$\text{Step movement, percent M.A.C.} = \text{c.g. limit shift, percent M.A.C.}\frac{\text{Gross load}}{\text{Load on water}}$$

where

c.g. limit shift = 5 percent mean aerodynamic chord

Gross load = 65.2 pounds

Load on water = 28.2 (The load on the water is taken at the speed and trim where lower limit porpoising occurs. Figure 16 shows that this point is approximately 22 feet per second and a trim of 5.5°. The aerodynamic lift at this condition is 37 pounds (fig. 8), resulting in a load on the water of 28.2 pounds.)

then,

$$\text{Step movement} = 5 \times \frac{65.2}{28.2} = 11.6 \text{ percent M.A.C. or 1.3 feet full size.}$$

Additional tests were made to determine the take-off stability with flaps 0° as a means of reducing the bow down pitching moments due to the flaps. The results of these tests, at a gross load corresponding to 26,000 pounds, are shown in figures 21 and 22. With -10° elevators no porpoising, exceeding 2° in amplitude, was observed at positions of the center of gravity between 18 and 28 percent mean aerodynamic chord. With -20° elevator high angle porpoising was excessive at center-of-gravity locations aft of 19 percent. A comparison of figures 20 and 22 indicates that reducing the flap deflection from 20° to 0° moved the range of stable locations of the center of gravity forward approximately 11 percent. Using the design step location, stable take-offs can then be made only if the deflection of the flaps is very small and deflection of the elevators is between -5° and -10°.

Effect of water in nose-wheel well.- In order to determine the effect of water in the forward wheel well on the take-off stability, a few runs were made with the drains open. The model was accelerated from rest to get-away at rates of acceleration of 1.1, 2.9, and 4.3 feet per second per second. Figure 23 shows the variation in trim with speed at these rates of acceleration with the drains open and closed.

A comparison of the trim tracks shows that when the drains are opened (water enters the wheel well) the free-to-trim track up to the hump is slightly lowered and the amplitudes of porpoising are slightly increased compared to when the drains are closed. The effect of the drains on the variation of maximum amplitude of porpoising with forward acceleration is shown in figure 24. From the plots of this figure and those of figure 19 it is estimated that if the drains are opened the forward center-of-gravity limit would be moved aft approximately 2 percent mean aerodynamic chord.

Landing stability.- A summary of the results of the landing tests, prepared from visual observations and trim and rise records is shown in the following table:

Vents at step	Landing trim (deg)	Landing behavior
Closed	3.5	1 skip
	6.0	1 skip
	6.2	2 skips
	7.0	3 skips
	8.2	Stable
	9.5	Stable
	11.0	1 skip
	12.5	2 skips
Open	4.5	1 heave
	7.0	1 skip
	7.5	1 skip
	9.5	Stable
	10.6	Stable
	12.2	Stable
	12.5	Stable

With vents closed, skipping occurred during landings at most trims, but this skipping was not violent. With the vents open, the tendency to skip during landings was effectively reduced, and the model skipped lightly only at trims where the afterbody keel was approximately parallel to the water (around 7.5°). Practically no porpoising occurred during the remainder of the landing run.

CONCLUSIONS

The tank tests of the model of the XJR2F-1 indicated the following characteristics:

1. At gross loads up to the normal (22,600 pounds full size) light spray entered the propeller disks over a very narrow range of speeds. The spray striking the flaps was not excessive. At planing speeds no appreciable wetting of the tail surface was noted.

2. The trim limits of stability appeared to be satisfactory and upper limit porpoising was not violent. The range of stable trims between the lower limit and the upper limit increasing trim was approximately 6.5°.

3. With flaps down 20° and -20° elevators, lower limit porpoising exceeded 2° amplitude at positions of the center of gravity forward of 28 percent mean aerodynamic chord. For stable take-off with the center of gravity at 23 percent mean aerodynamic chord the step should be moved forward approximately 1.3 feet full size.

4. With 0° flaps and -10° elevators, take-off stability was satisfactory at positions of the center of gravity between 18.0-percent and 28.5 percent mean aerodynamic chord.

5. The effect of decreasing the flap deflection from 20° to 0° on the forward center-of-gravity limit was to move it forward approximately 11 percent mean aerodynamic chord.

6. Water in the nose-wheel well decreased the trim and increased the probability of encountering lower limit porpoising at forward positions of the center of gravity. This effect was approximately equal to a forward movement of the center of gravity of 2 percent mean aerodynamic chord.

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7. With the vents closed, the model skipped during landings at most trims, but this skipping was not violent. With the vents open, the model skipped lightly only at trims where the afterbody keel was approximately parallel to the water (around 7.5°).

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3. Olson, Roland E., and Land, Norman S.: The Longitudinal Stability of Flying Boats as Determined by Tests of Models in the NACA Tank. I - Methods Used for the Investigation of Longitudinal-Stability Characteristics. NACA ARR, Nov. 1942.

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5. Brader, Robert E.: Estimated Weight and Balance Report XJR2F-1. Grumman Aircraft Eng. Corp. Rep. No. 2951. (Contract NOa (s) - 4346.)

TABLE I

MODEL PARTICULARS OF GRUMMAN XJR2F-1 AMPHIBIAN

Item		NACA model 212 1/7 size	Grumman XJR2F-1 full size
Hull			
	Beam, maximum, in.	13.58	95.0
	Length of forebody, in.	44.57	312.0
	Length of afterbody, in.	36.00	252.0
	Length of tail extension, in.	23.15	167.0
	Length over all, in.	103.72	731.0
	Length-beam ratio	5.92	5.92
	Type of step	Transverse	Transverse
	Depth of step at keel, in.	0.97	6.8
	Depth of step at keel, percent beam	7.1	7.1
	Angle of deadrise at step, deg		
	Excluding chine flare	22.5	22.5
	Including chine flare	19.5	19.5
	Angle of forebody keel, deg	0	0
	Angle of afterbody keel, deg	6.5	6.5
	Angle of sternpost to baseline, deg	8.0	8.0
	Angle of forebody chine flare at step, deg	-10.0	-10.0
	Area of ventilation ducts, sq in.	3.16	155.0
Wing			
	Area, sq ft	16.8	822.0
	Span, in.	137.14	960.0
	Root chord, in.	22.56	157.9
	Angle of incidence at root, deg	5.0	5.0
	Mean aerodynamic chord (M.A.C.)		
	Length, in.	18.42	129.1
	Leading edge aft of bow, in.	35.53	249.0
	Leading edge forward of step, in.	9.04	63.3
	Leading edge above base line, in.	19.20	134.4
Horizontal tail surface			
	Area, sq ft	3.47	170.0
	Span, in.	49.72	348.0
	Angle of stabilizer to wing chord, deg	-0.5[a]	-1.5
	Elevator, root chord, in.	8.06	56.4
	Elevator, semispan, in.	24.86	174.0
	Length from 25 percent M.A.C. of wing to hinge line of elevators, in.	55.43	388.0

[a]Not scale value of full size.

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TABLE I- Concluded

MODEL PARTICULARS OF GRUMMAN XJR2F-1 AMPHIBIAN - Concluded

Item	NACA model 212 1/7 size	Grumman XJR2F-1 full size
Propellers		
Number of propellers	2.0	2.0
Number of blades	3.0	3.0
Diameter, in.	19.5[a]	133.0
Angle of thrust line to base line, deg.	5.0	5.0
Angle of blade at 0.75 radii, deg.	12.0	-----
Clearance above keel line, in.	12.6[a]	86.5

[a] Not scale value of full size.

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TABLE II

LOADING CONDITION

Condition	Load coefficient C_{Δ_o}	Model load Δ_o (lb)	Full-size load (lb)
Maximum	0.82	75.0	26,000
Normal	.71	65.2	22,600
Minimum	.55	50.5	17,500

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FIGURE LEGENDS.- Concluded

Figure 15.- Model 212. Trim limits of stability, power off and power on. Gross load 75.0 pounds (26,000 pounds full-size). Flaps deflected 20°.

Figure 16.- Model 212. Variation of trim with speed. Gross load, 65.2 pounds (22,600 pounds full-size); full power; flaps, 20°.

Figure 17.- Model 212. Variation of trim with speed. Gross load, 70.2 pounds (24,300 pounds full-size); full power; flaps, 20°.

Figure 18.- Model 212. Variation of trim with speed. Gross load, 75.0 pounds (26,000 pounds full-size); full power; flaps, 20°.

Figure 19.- Model 212. Maximum amplitude of porpoising at several gross loads, elevator settings, and locations of the center of gravity. Full power; flaps, 20°.

Figure 20.- Model 212. Effect of gross load on the limits of stable locations of the center of gravity. Full power; flaps, 20°.

Figure 21.- Model 212. Variation of trim with speed. Gross load, 75.0 pounds (26,000 pounds full-size); full power; flaps, 0°.

(a) Center of gravity locations 18 to 32 percent M.A.C.

Figure 21.- Concluded.

(b) Center of gravity locations 34 and 35.5 percent M.A.C.

Figure 22.- Model 212. Maximum amplitude of porpoising at several elevator deflections and locations of the center of gravity. Gross load, 75.0 pounds (26,000 pounds full-size); full power; flaps, 0°.

Figure 23.- Model 212. Effect of nose-wheel drains on trim tracks for several accelerations. Gross load 65.2 pounds; full power; center of gravity 30 percent M.A.C.; flaps, 20°; elevators, -30°.

Figure 24.- Effect of nose-wheel drains on maximum amplitude of porpoising for several accelerations. Gross load, 65.2 pounds; full power; center of gravity, 30-percent M.A.C.; flaps, 20°; elevators, -30°.

FIGURE LEGENDS

Figure 1.- General arrangement of model 212.

Figure 2.- Model 212. 1/7-full size model of Grumman XJR2F-1.

Figure 3.- Model 212. Effective thrust for model and comparison with scale thrust from Grumman estimate.

Figure 4.- Model 212. Aerodynamic lift and pitching moment. Power off; flaps, 20°; elevators, -10°; speed, 40 feet per second.

Figure 5.- Model 212. Aerodynamic lift and pitching moment. Power off; flaps, 45°; elevators, -10°; speed, 40 feet per second.

Figure 6.- Model 212. Aerodynamic lift and pitching moment. Full power; flaps, 0°; speed, 40 feet per second.

Figure 7.- Model 212. Aerodynamic lift and pitching moment. Full power; flaps, 20°; speed, 40 feet per second.

Figure 8.- Model 212. Aerodynamic lift characteristics with full power. Flaps deflected, 20°; elevators deflected, -10°.

Figure 9.- Model 212. Aerodynamic trim curves. Flaps, 20°; speed, 40 feet per second.

Figure 10.- Model 212. Aerodynamic trim curves. Flaps, 0°; speed, 40 feet per second; center of gravity at 25-percent M.A.C.

Figure 11.- Model 212. Spray characteristics, bow. Gross load, Δ_o, 65.2 pounds (22,600 pounds full size); full power, 7100 rpm; center of gravity, 20-percent mean aerodynamic chord; flap deflection, 0°; elevator deflection, -10°.

Figure 12.- Model 212. Spray characteristics, bow. Gross load, Δ_o, 75 pounds (26,000 pounds full size); full power, 7100 rpm; center of gravity, 20-percent mean aerodynamic chord; flap deflection, 0°; elevator deflection, -10°.

Figure 13.- Model 212. Speed range over which spray enters the propellers. Full power, 7100 rpm, center of gravity, 20 percent M.A.C.; flap deflection, 0°; elevator deflection, -10°.

Figure 14.- Model 212. Speed range over which spray strikes the flaps. Full power, 7100 rpm; center of gravity, 20 percent M.A.C.; flap deflection, 0°; elevator deflection, -10°.

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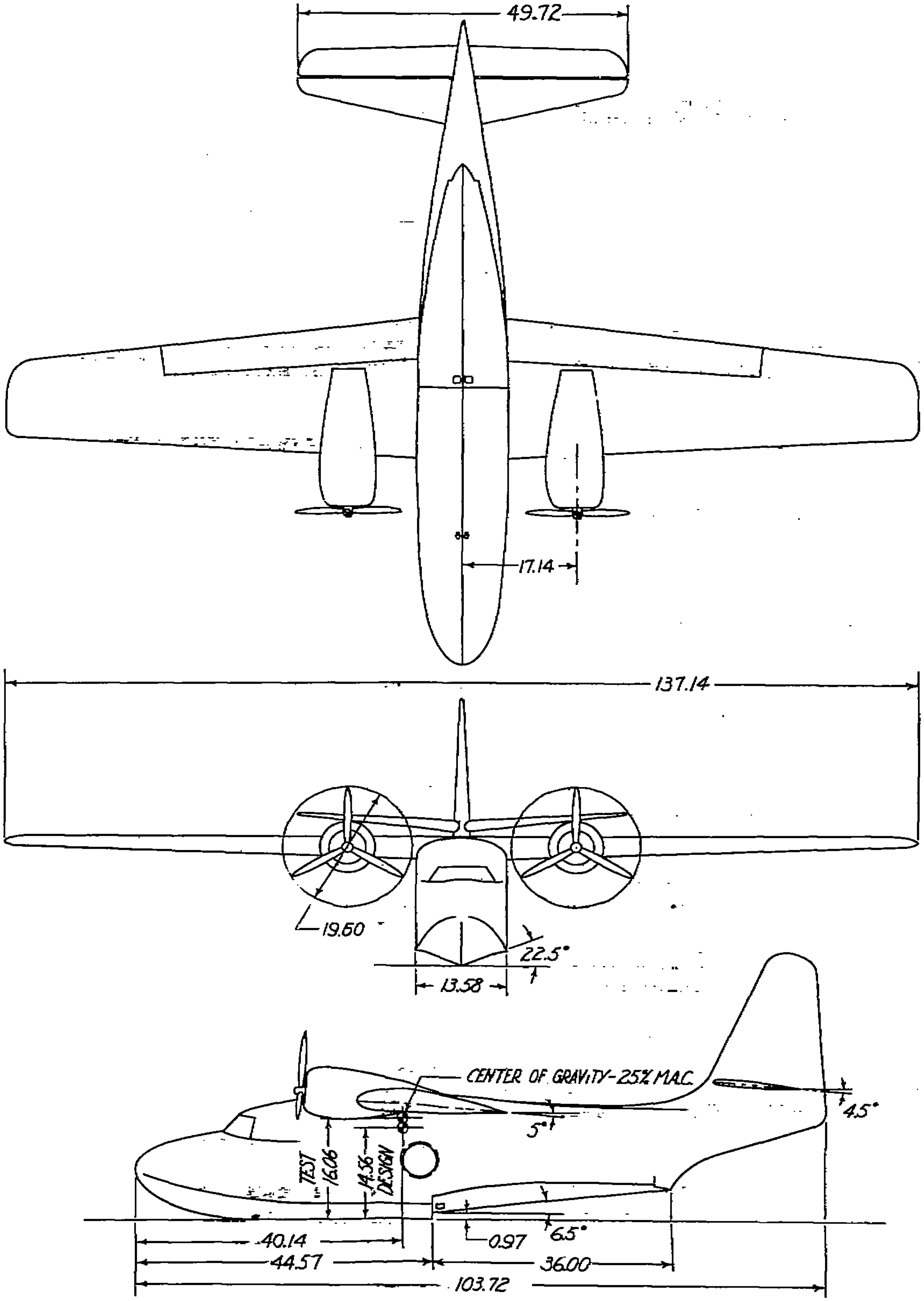

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FIGURE 1.- GENERAL ARRANGEMENT OF MODEL 212.

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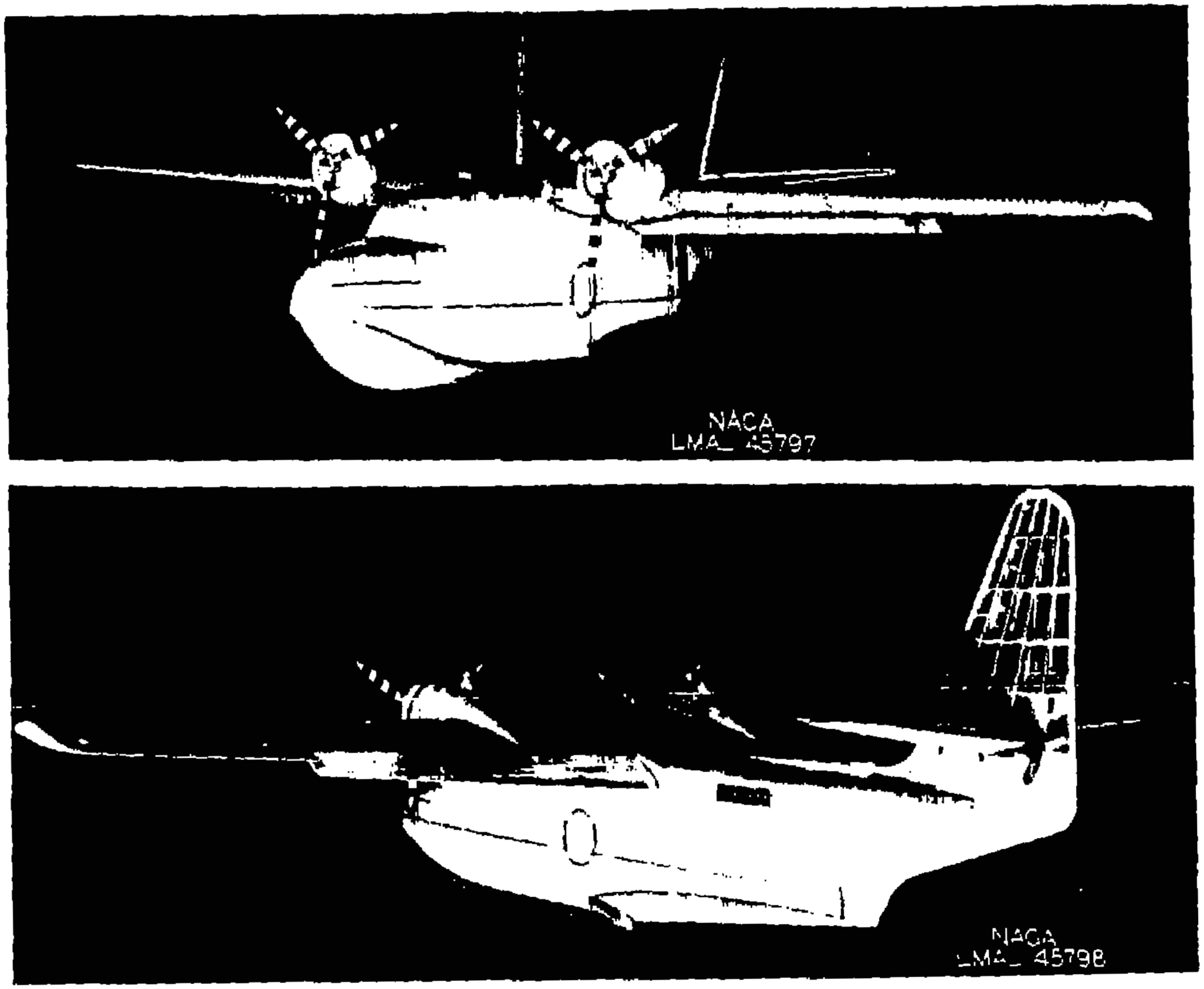

Figure 2.- Model 212. 1/7-full size model of Grumman XJR2F-1.

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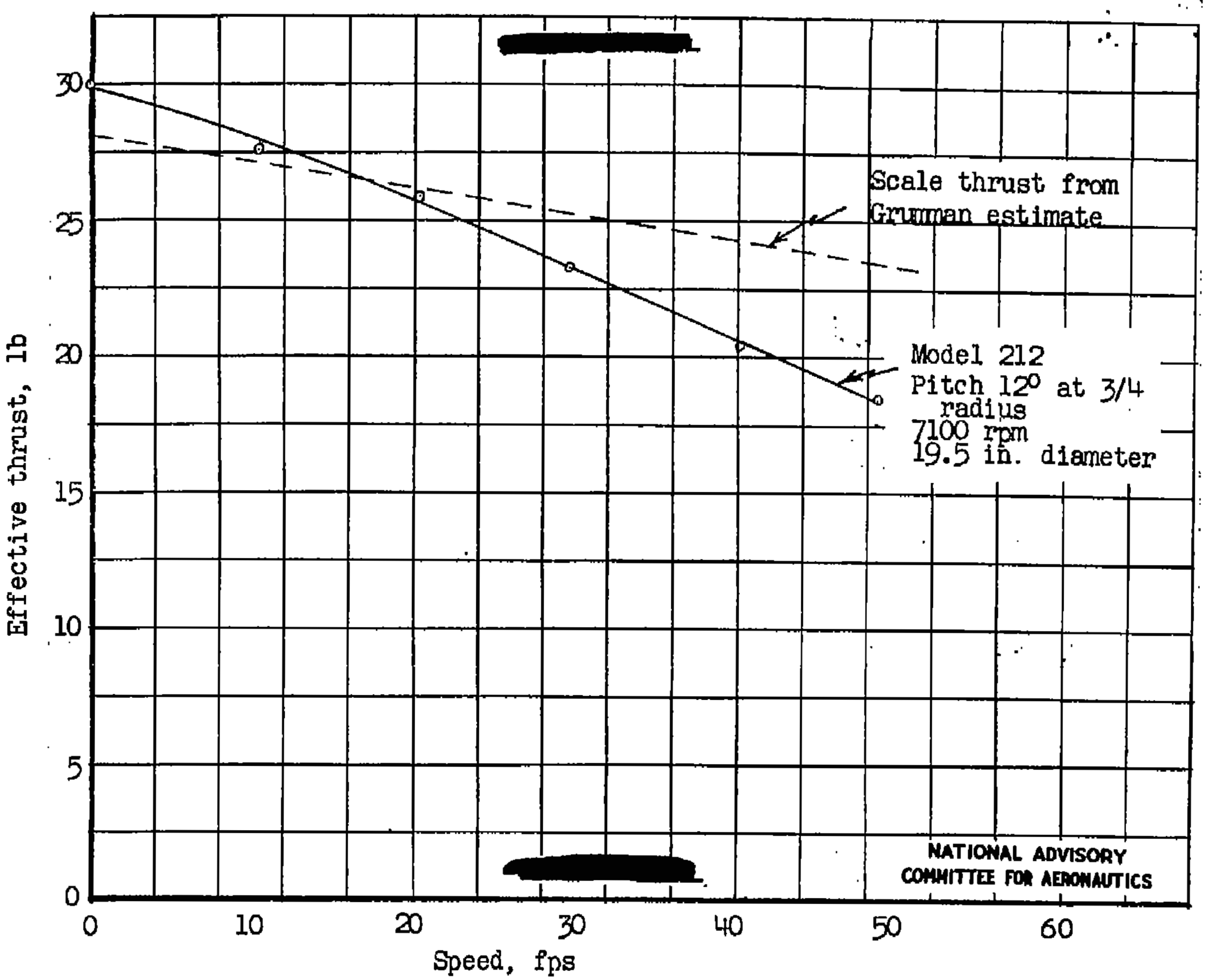

Figure 3 .- Model 212. Effective thrust for model and comparison with scale thrust from Grumman estimate.

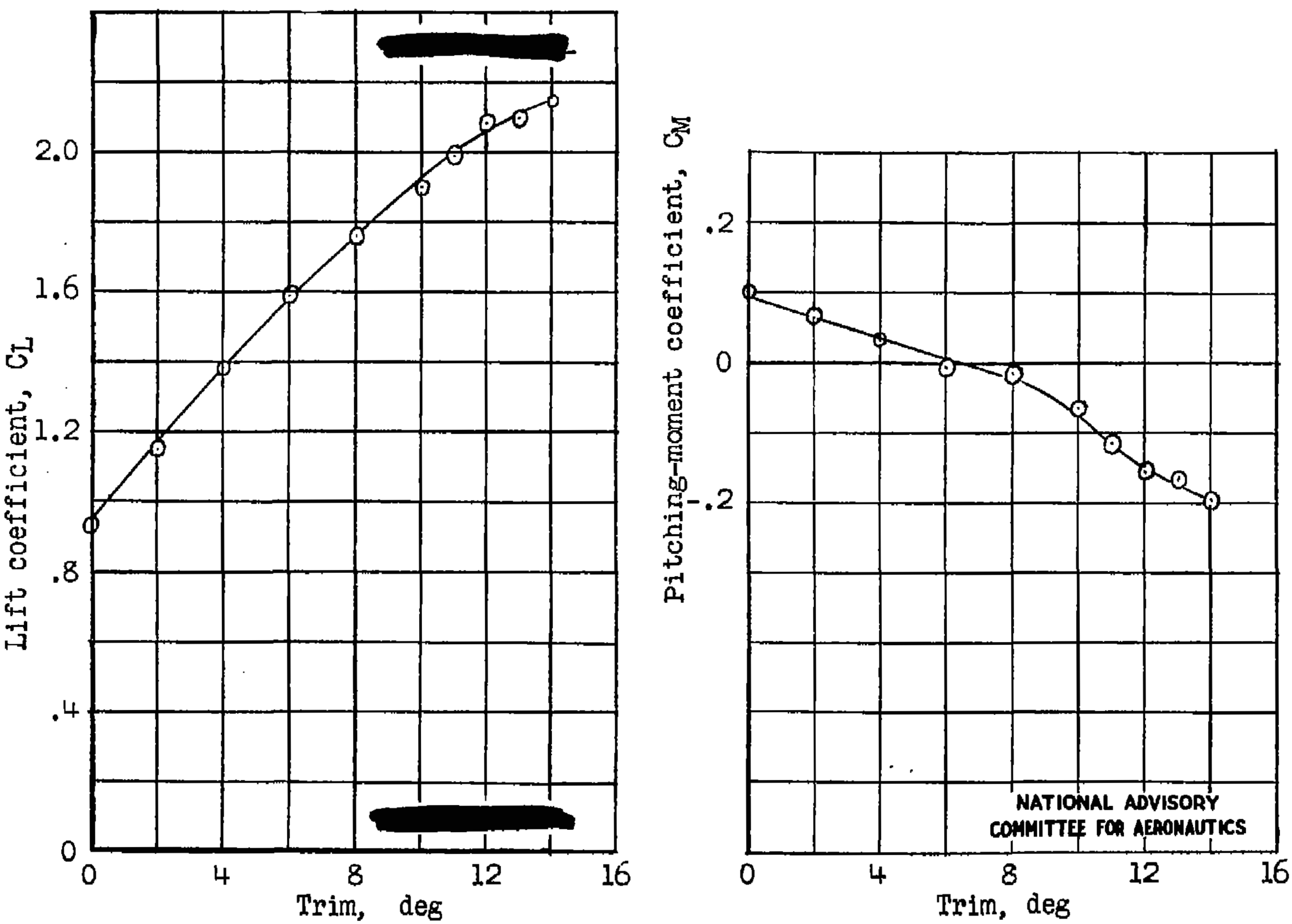

Figure 4 .- Model 212. Aerodynamic lift and pitching moment. Power off; flaps, 20°; elevators, -10° ; speed, 40 feet per second.

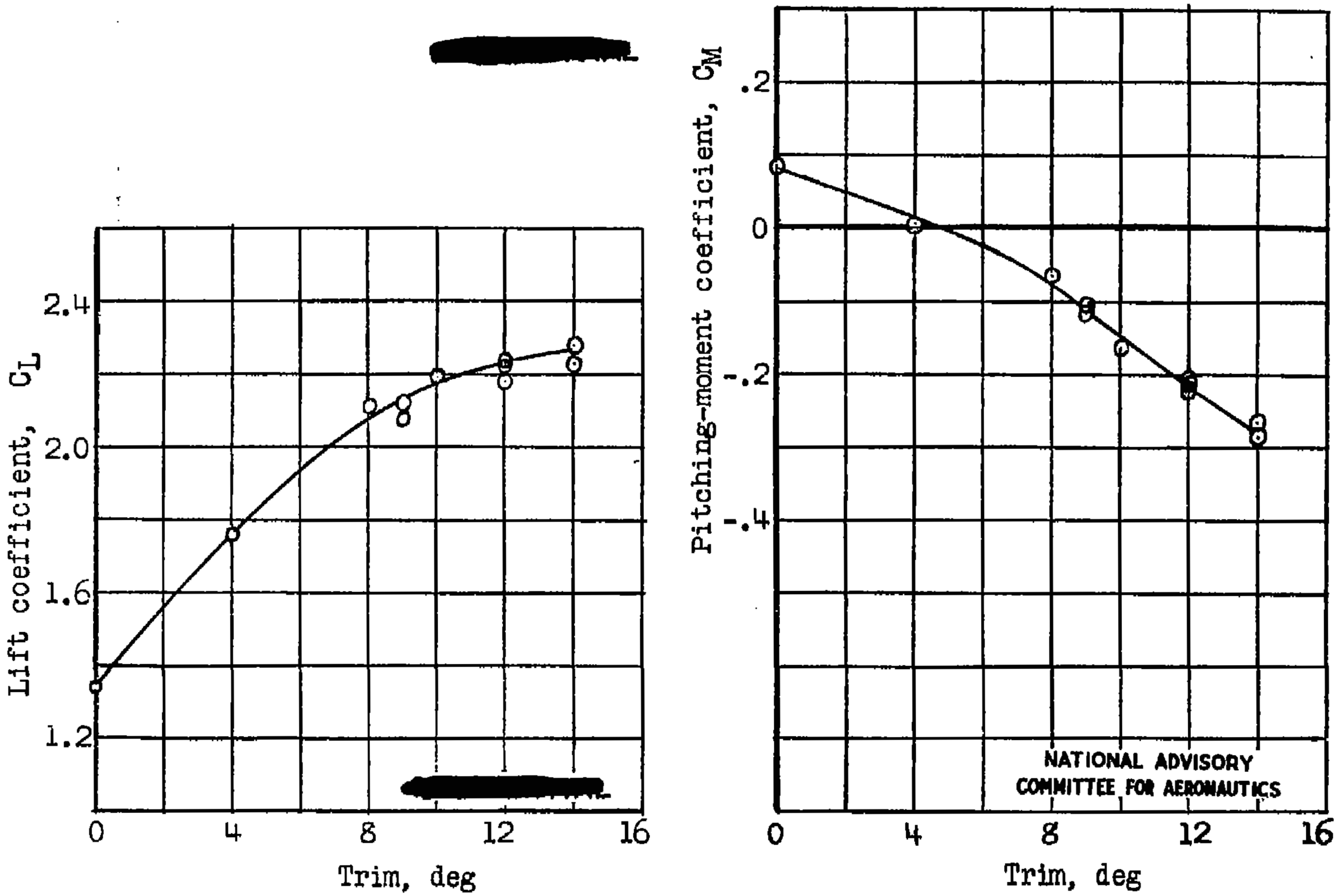

Figure 5.- Model 212. Aerodynamic lift and pitching moment. Power off; flaps, 45°; elevators, -10° ; speed, 40 feet per second.

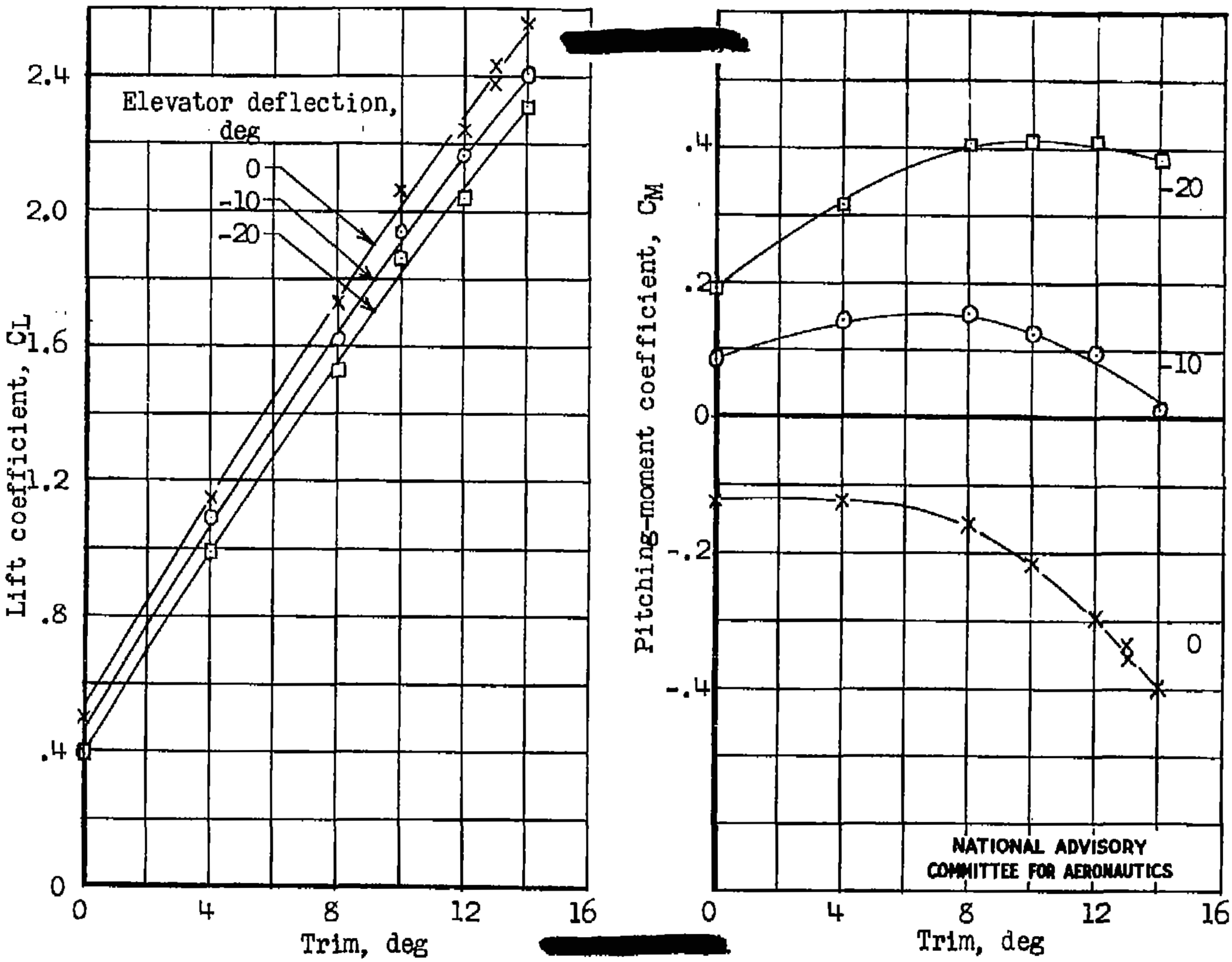

Figure 6 .- Model 212. Aerodynamic lift and pitching moment. Full power; flaps, 0^o; speed, 40 feet per second.

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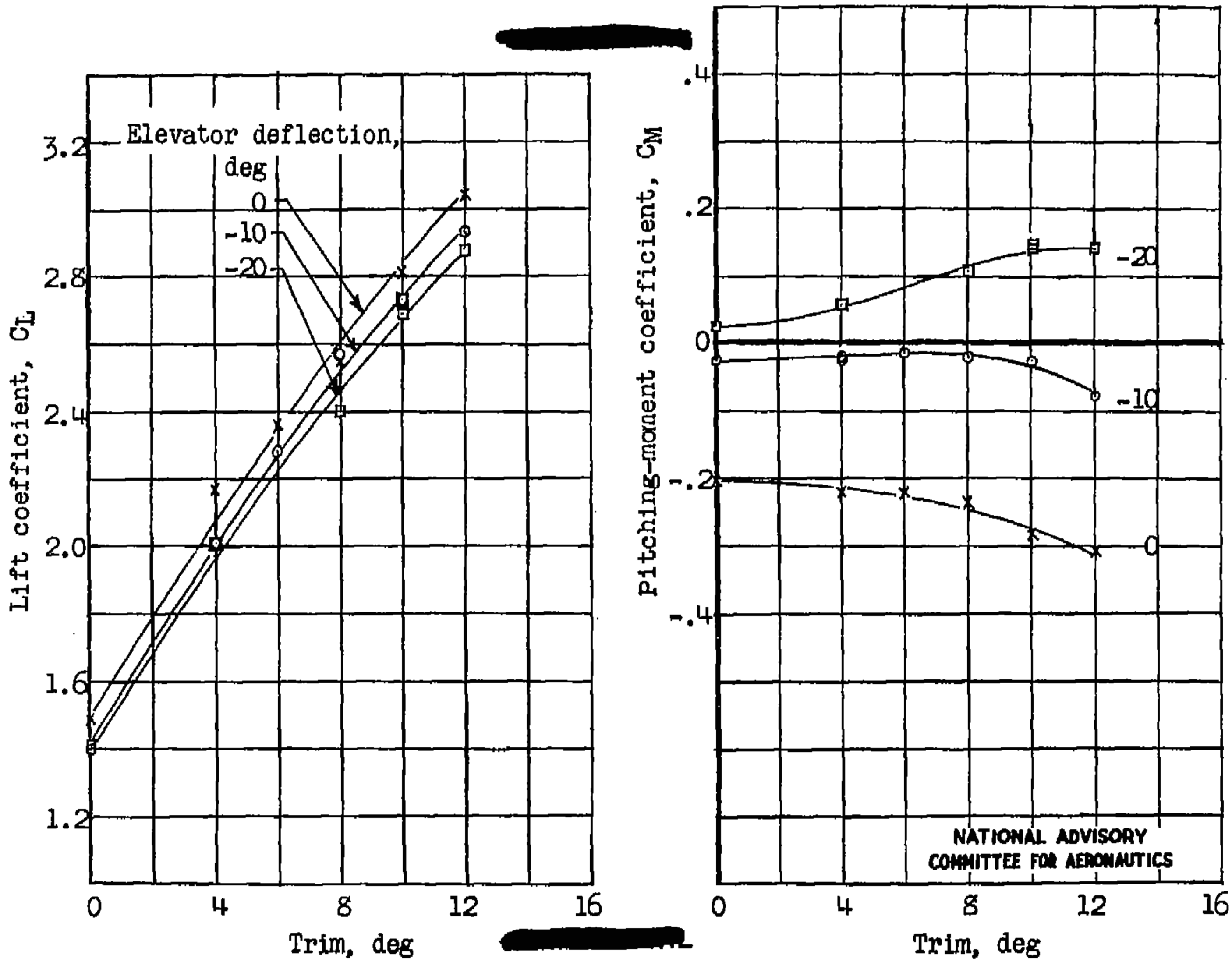

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Figure 7.- Model 212. Aerodynamic lift and pitching moment. Full power; flaps, 20°; speed, 40 feet per second.

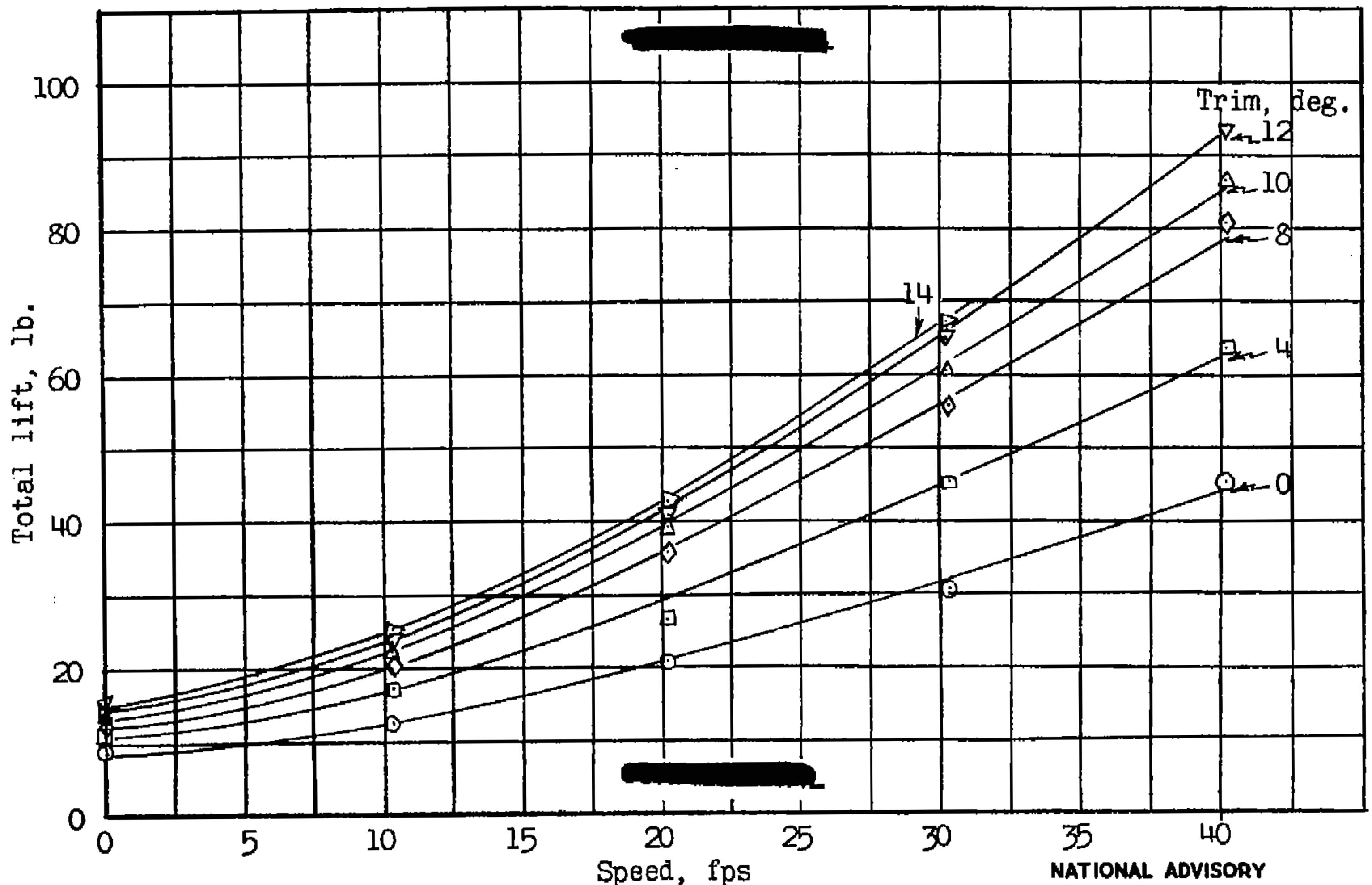

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Figure 8.- Model 212. Aerodynamic lift characteristics with full power. Flaps deflected, 20°; Elevators deflected, -10°.

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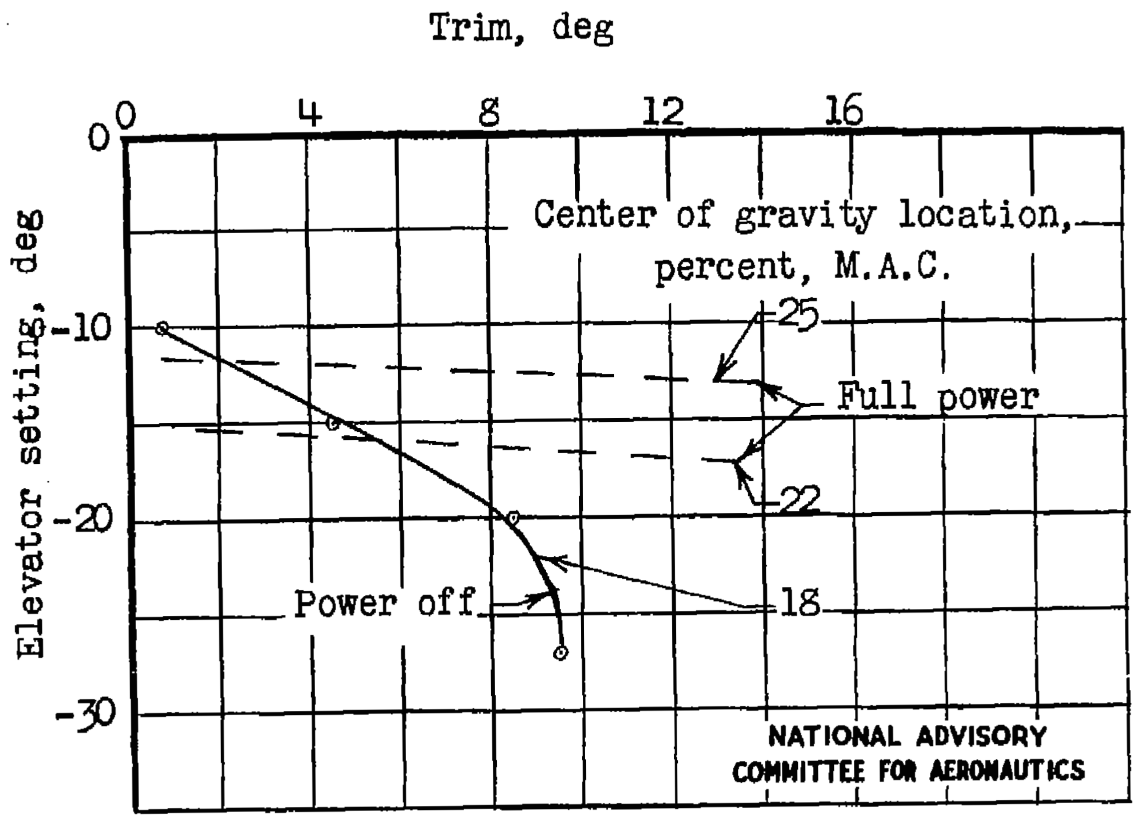

Figure 9 .- Model 212. Aerodynamic trim curves. Flaps, 20°; speed, 40 feet per second.

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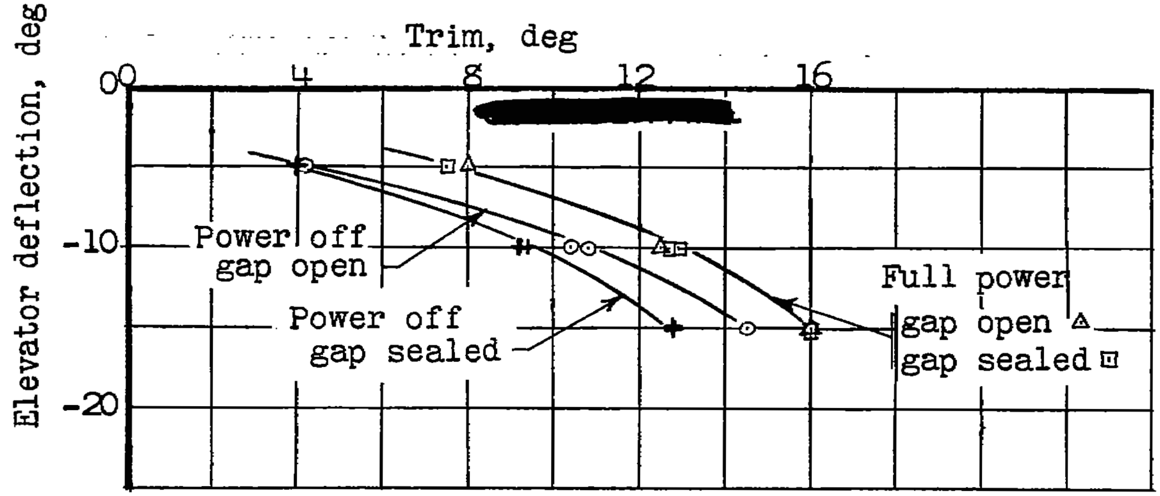
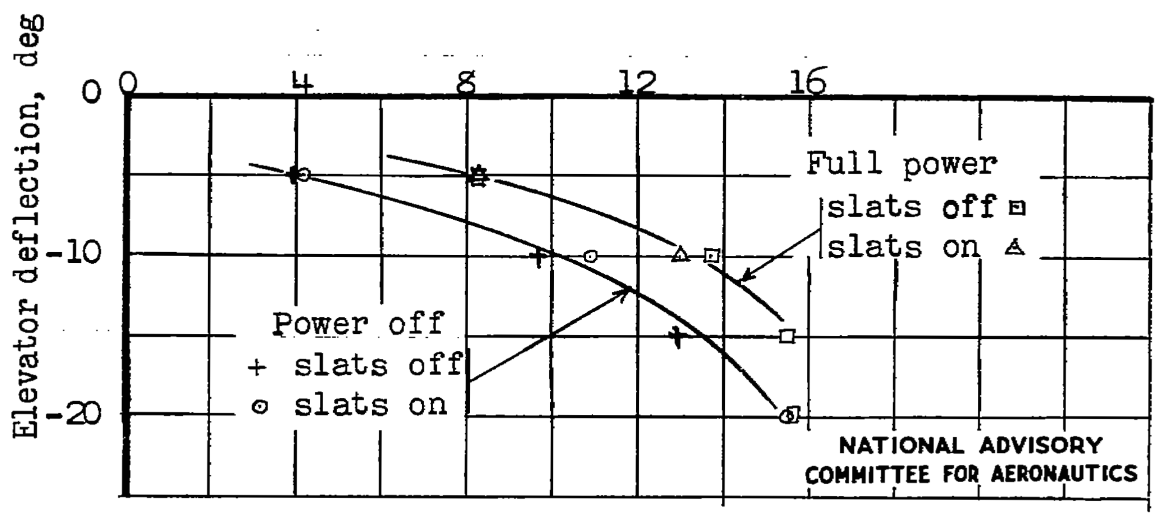


(a) Effect of elevator gap



(b) Effect of slats on leading edge of wing

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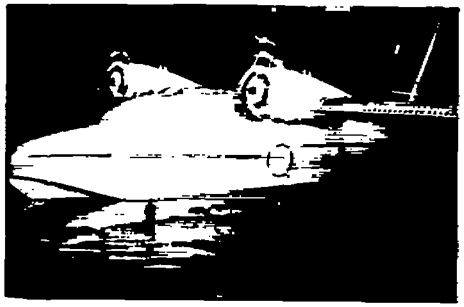
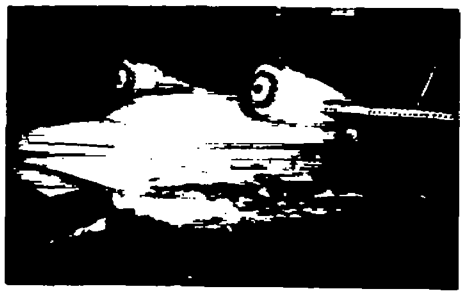
Figure 10.- Model 212. Aerodynamic trim curves. Flaps, 0°; speed, 40 feet per second; center of gravity at 25-percent M.A.C.

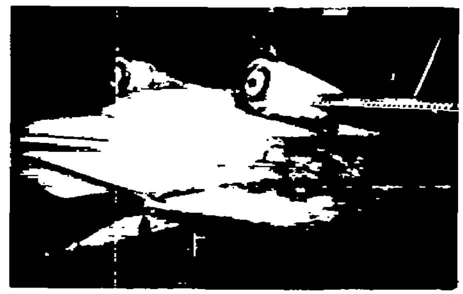


Speed, V, 0 fps; trim, τ, 1.4°.

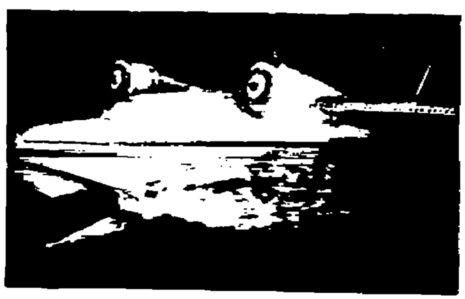
Speed, V, 11 fps; trim, τ, 5.1°.



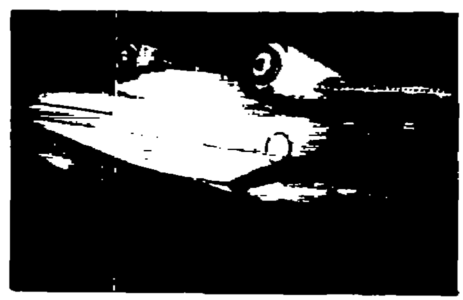
V, 9 fps; τ, 4.9°.



V, 12 fps; τ, 5.8°.



V, 10 fps; τ, 5.0°.



V, 15 fps; τ, 8.8°.

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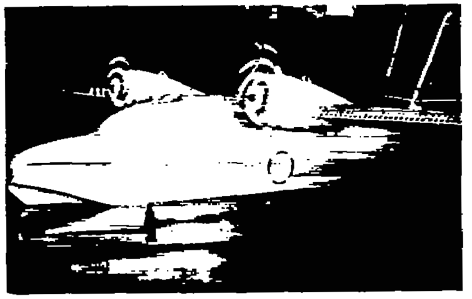
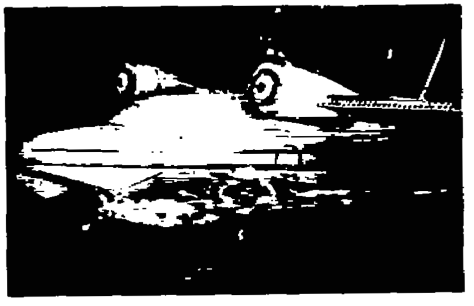
Figure 11.- Model 212. Spray characteristics, bow. Gross load, Δ_o, 65.2 pounds (22,600 pounds full size); full power, 7100 rpm; center of gravity, 20-percent mean aerodynamic chord; flap deflection, 0°; elevator deflection, -10°.

[redacted]

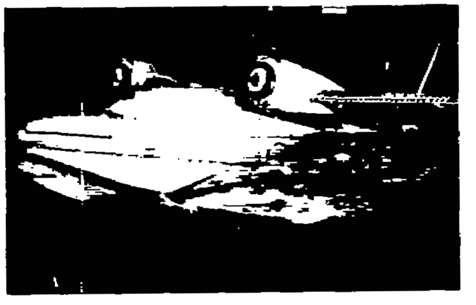


Speed, V, 0 fps; trim, τ, 1.2°.

Speed, V, 10 fps; trim, τ, 5.0°.



V, 8 fps; τ, 4.2°.



V, 13 fps; τ, 7.0°.

V, 9 fps; τ, 4.7°.

V, 15 fps; τ, 9.0°.

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Figure 12.- Model 212. Spray characteristics, bow. Gross load, Δ_0, 75 pounds (26,000 pounds full size); full power, 7100 rpm; center of gravity, 20-percent mean aerodynamic chord; flap deflection, 0°; elevator deflection, -10°.

[redacted]

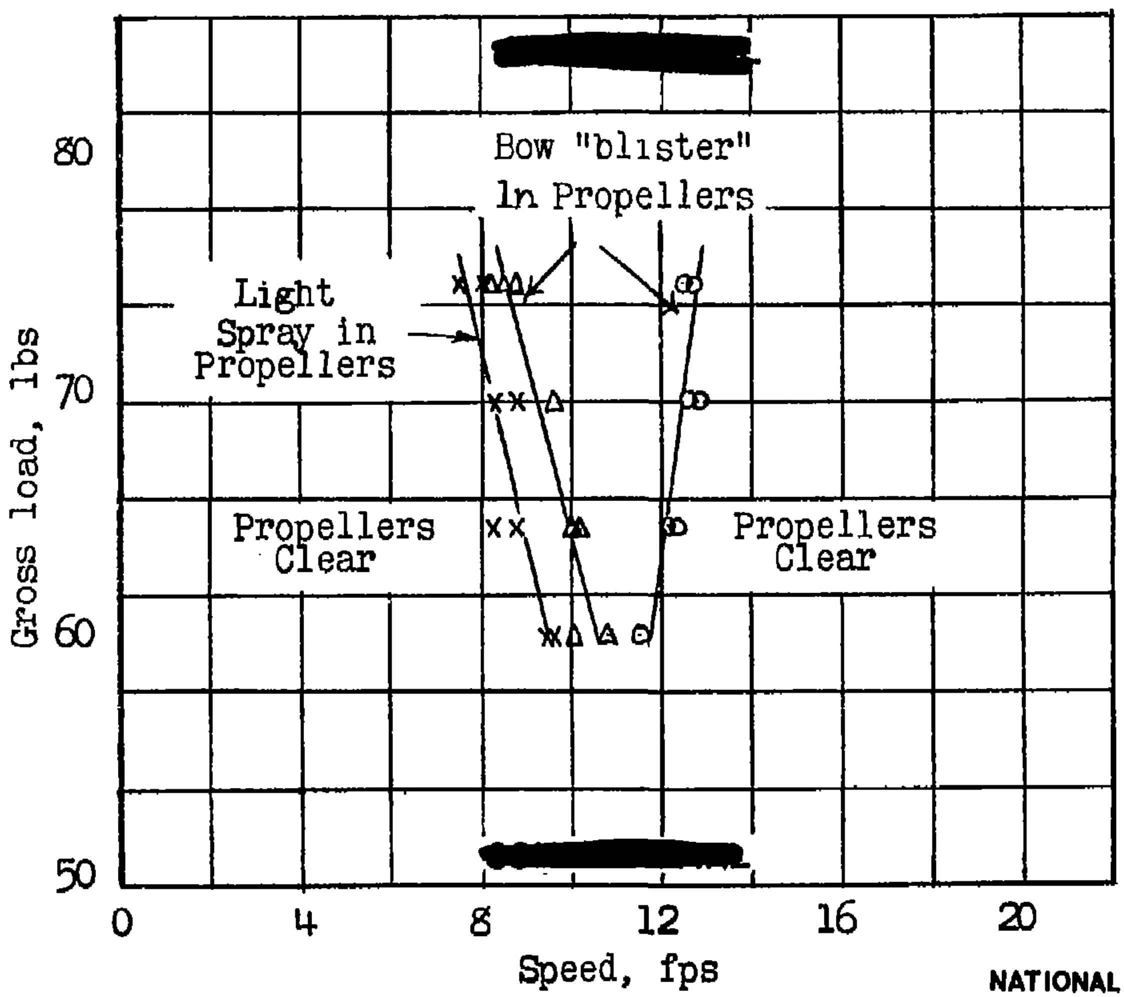

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Figure 13 .- Model 212. Speed range over which spray enters the propellers. Full power, 7100 rpm; center of gravity, 20 percent M.A.C.; flap deflection, 0°; elevator deflection, -10°.

[redacted]

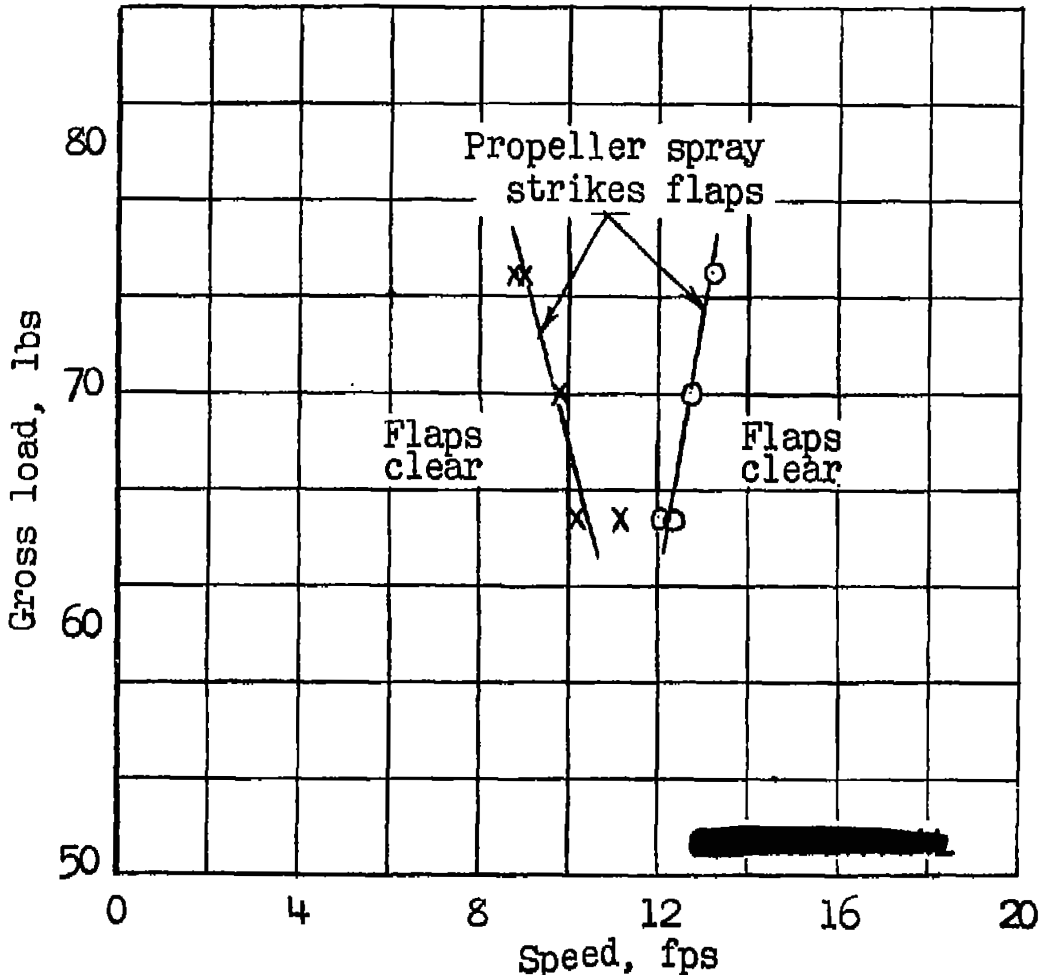

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Figure 14. - Model 212. Speed range over which spray strikes the flaps. Full power, 7100 rpm; center of gravity, 20 percent M.A.C.; flap deflection, 0°; elevator deflection, -10°.

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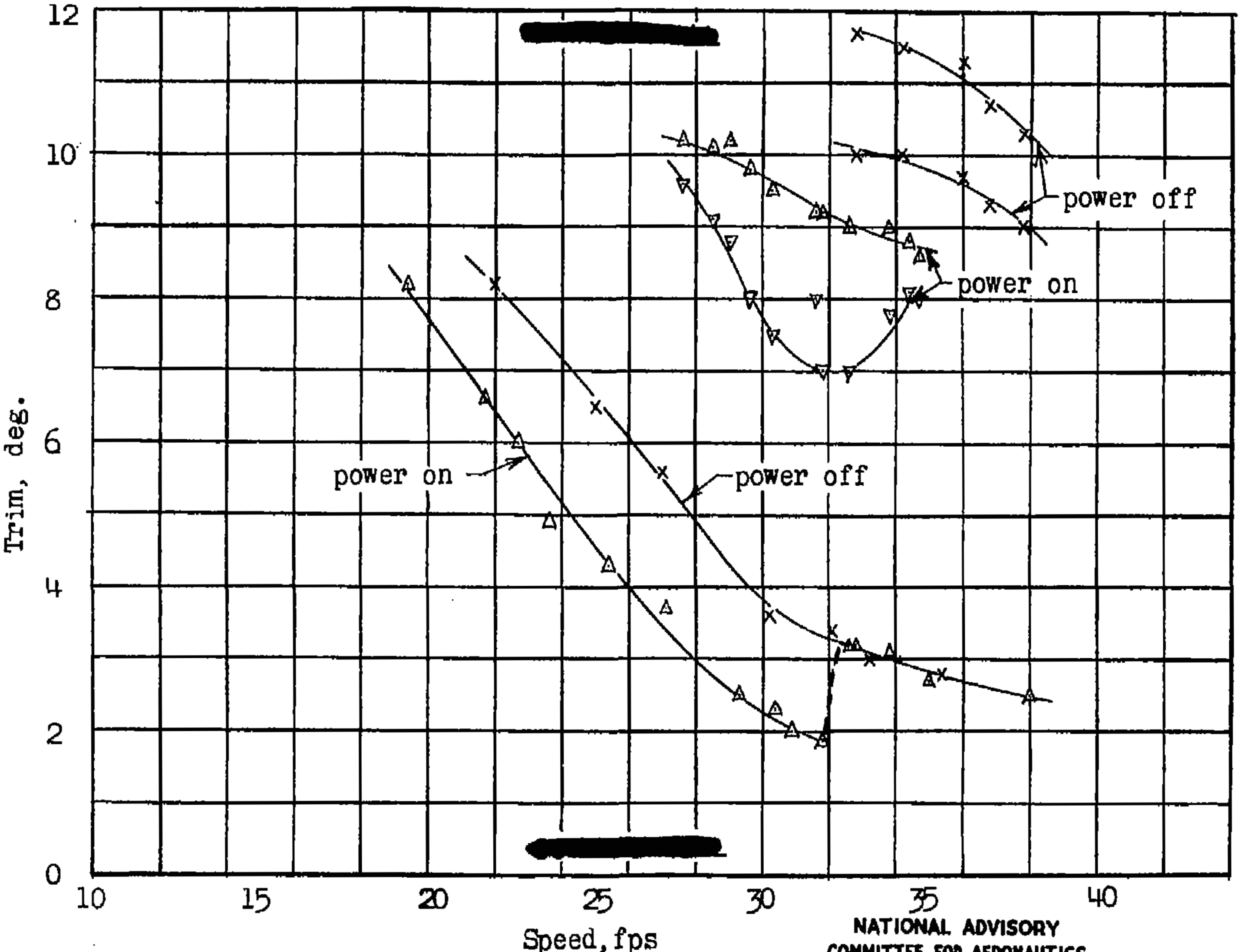

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Figure 15.- Model 212. Trim limits of stability, power off and power on. Gross load 75.0 pounds (26,000 pounds full-size). Flaps deflected 20°.

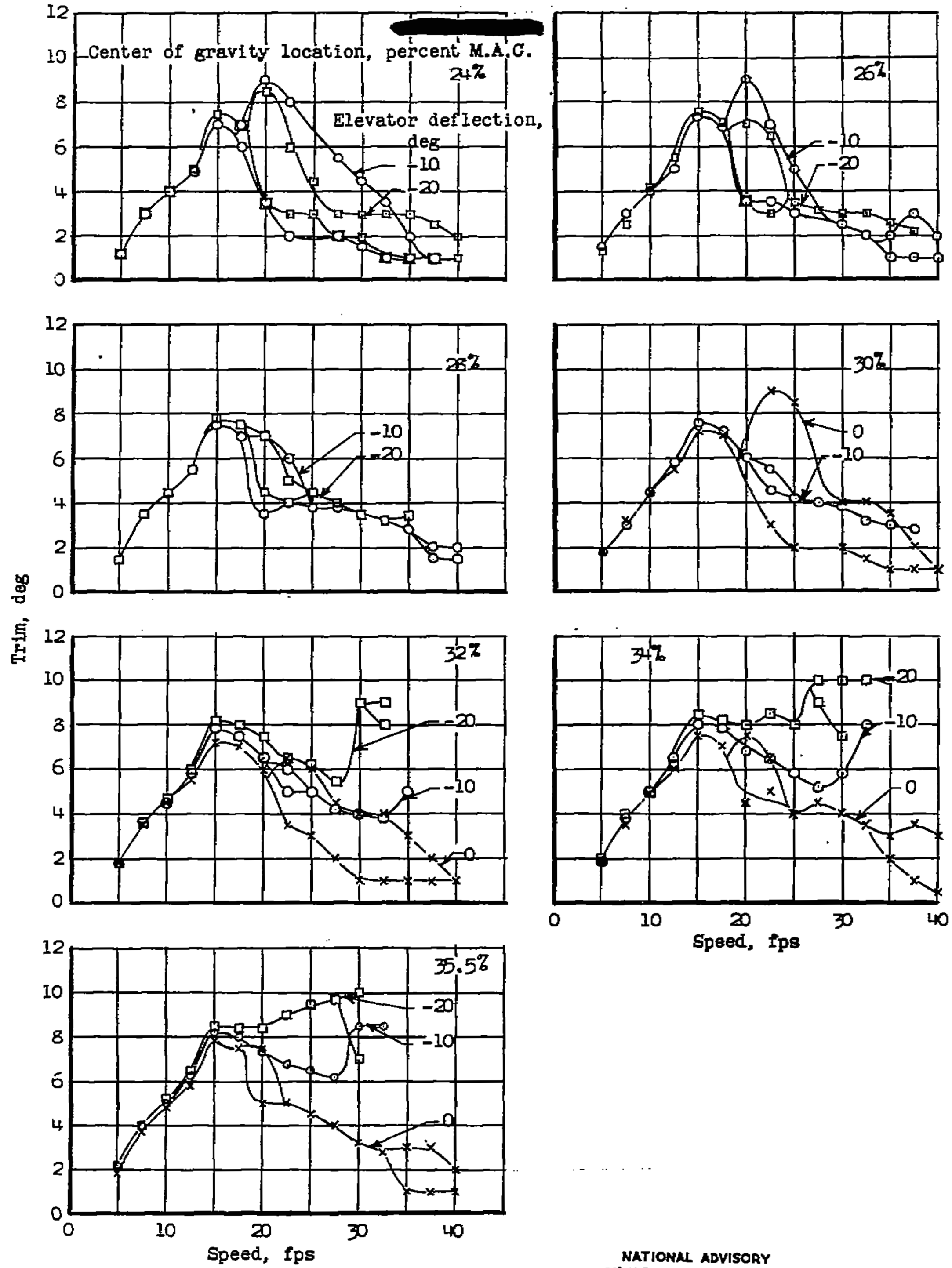

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Figure 16.- Model 212. Variation of trim with speed. Gross load, 65.2 pounds (22,600 pounds full-size); full power; flaps, 20°.

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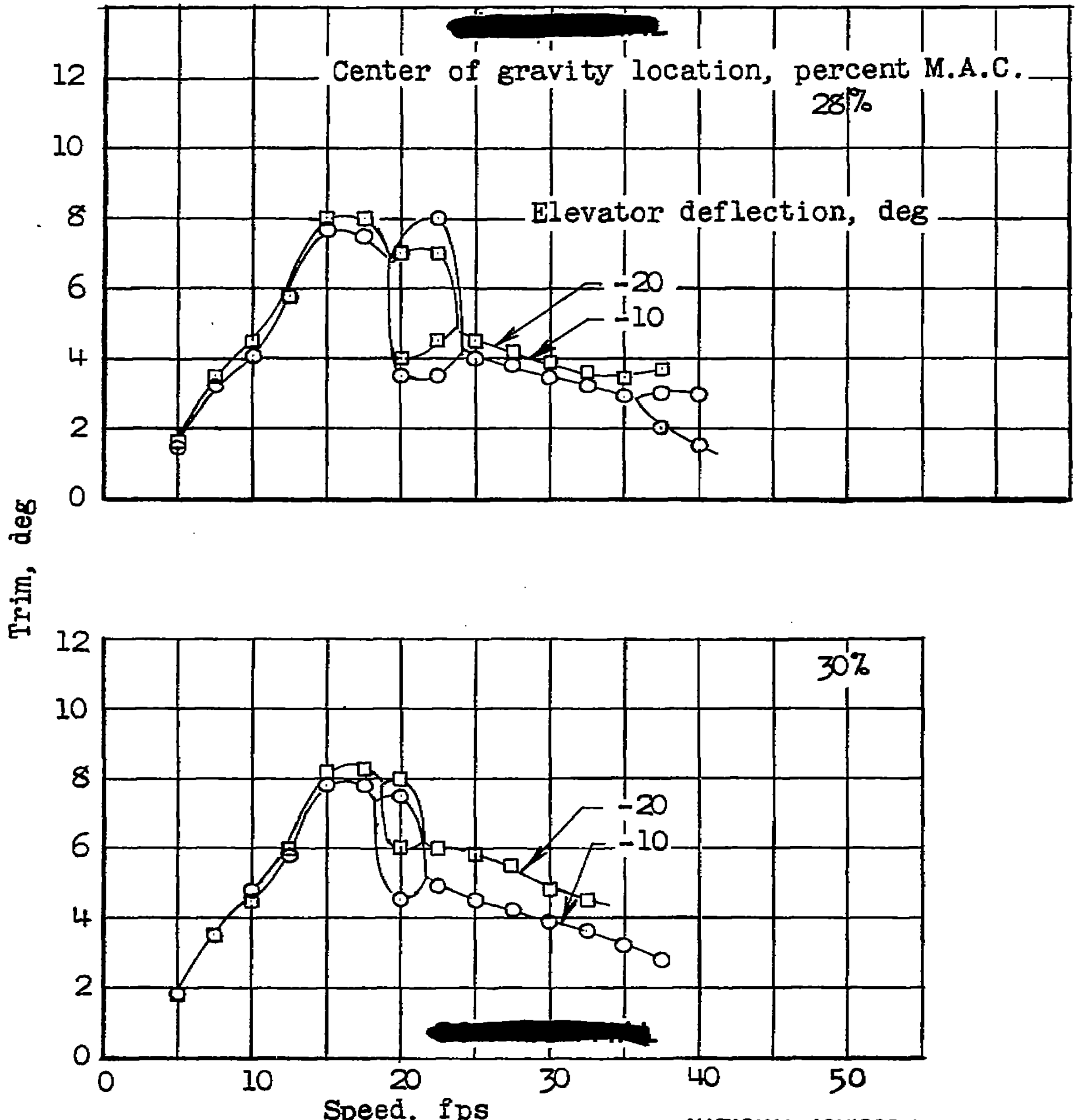

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Figure 17 .- Model 212. Variation of trim with speed. Gross load, 70.2 pounds (24,300 pounds full-size); full power; flaps, 20°.

[redacted]

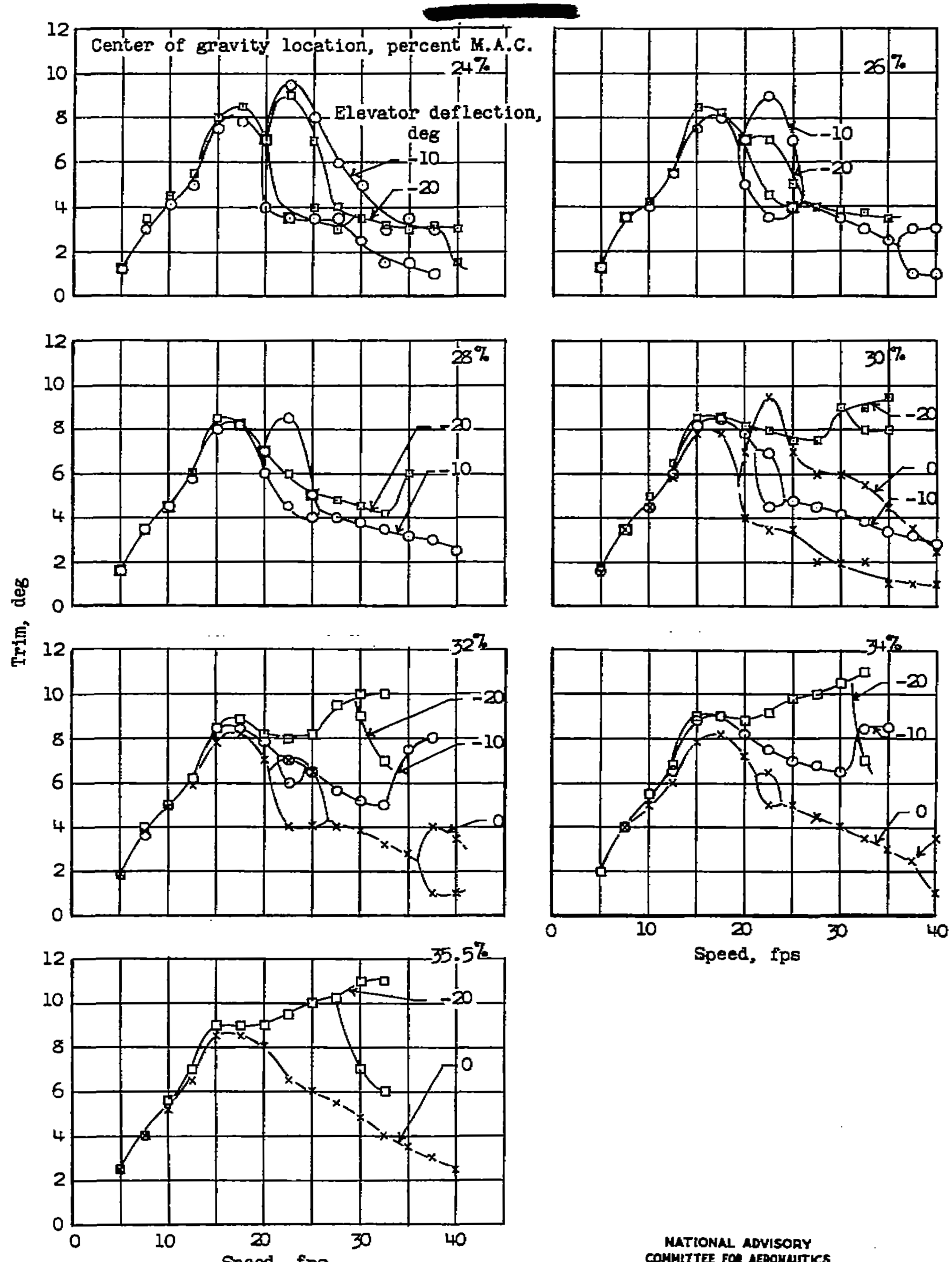

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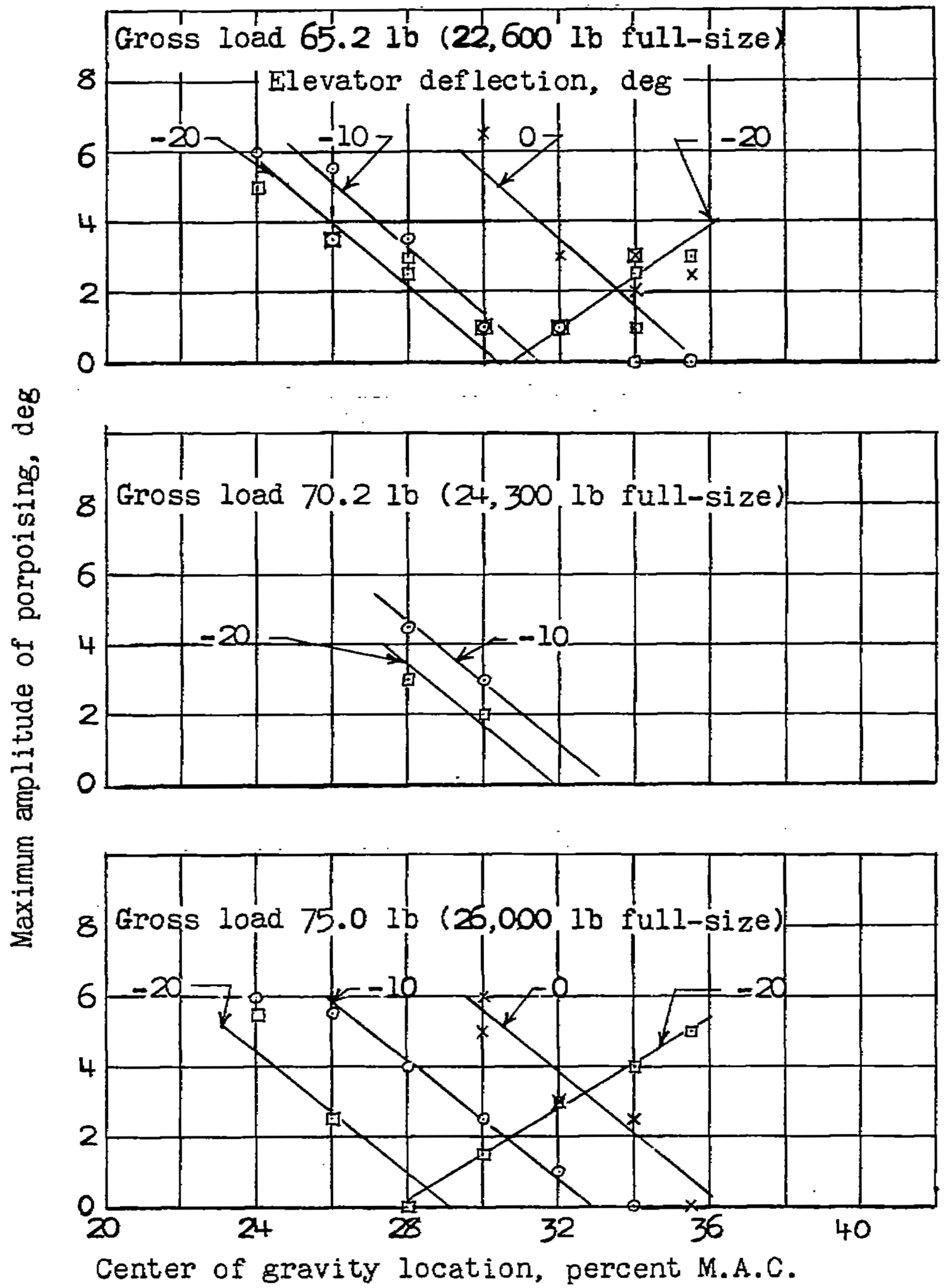
Figure 18.- Model 212. Variation of trim with speed. Gross load, 75.0 pounds (26,000 pounds full-size); full power; flaps, 20°.

[redacted]



[redacted]

Figure 19.- Model 212. Maximum amplitude of porpoising at several gross loads, elevator settings, and locations of the center of gravity. Full power; flaps, 20°.

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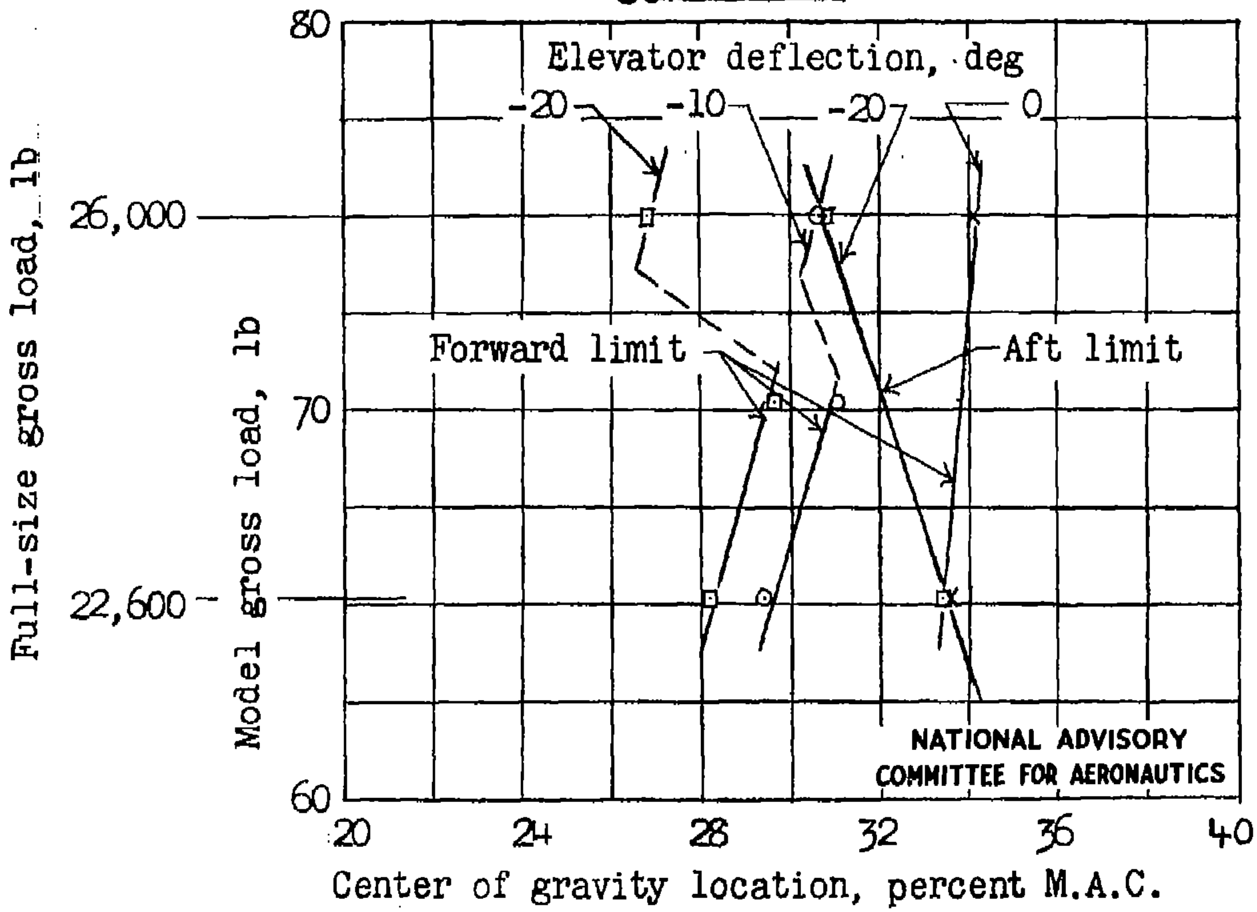
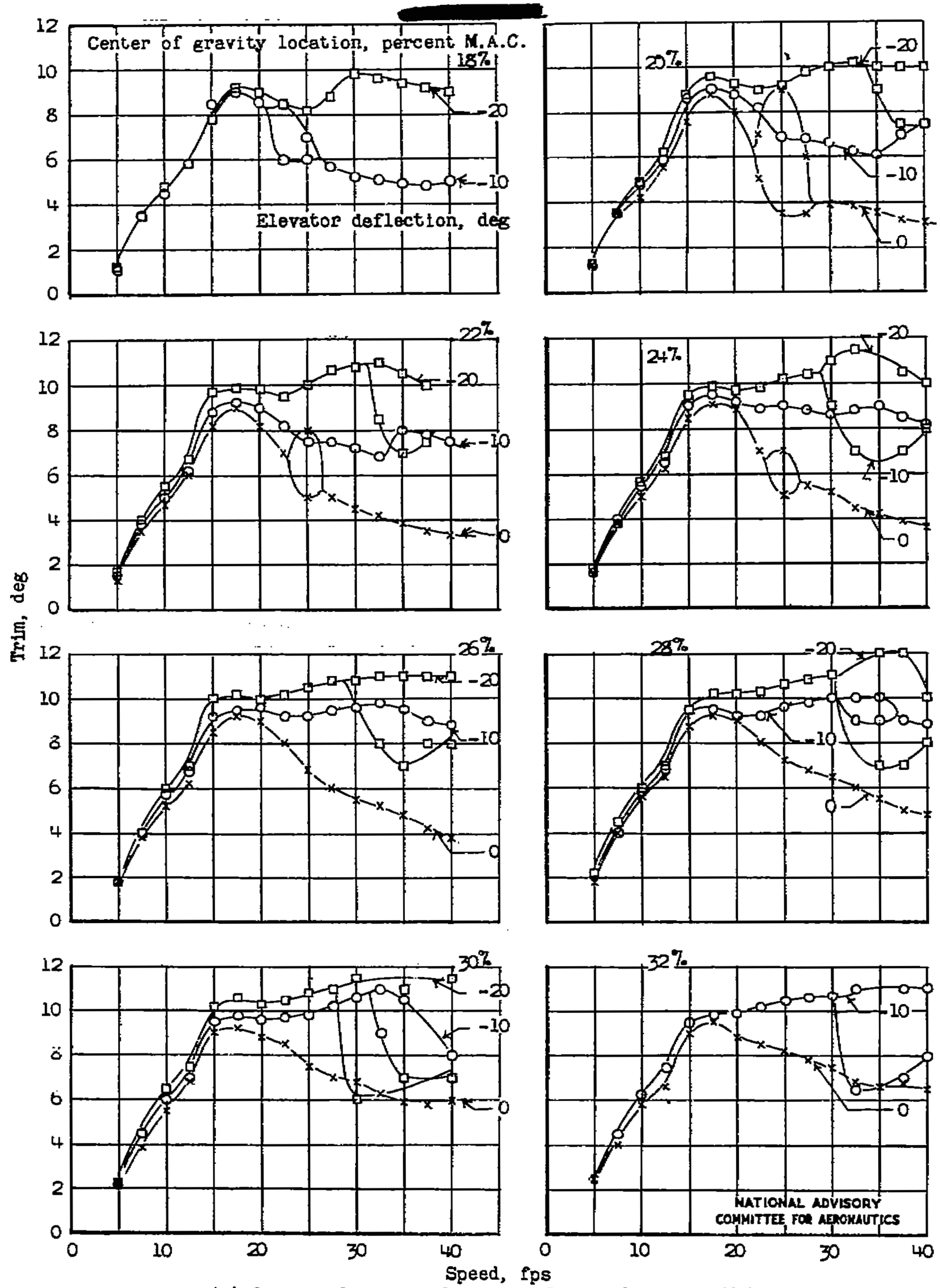


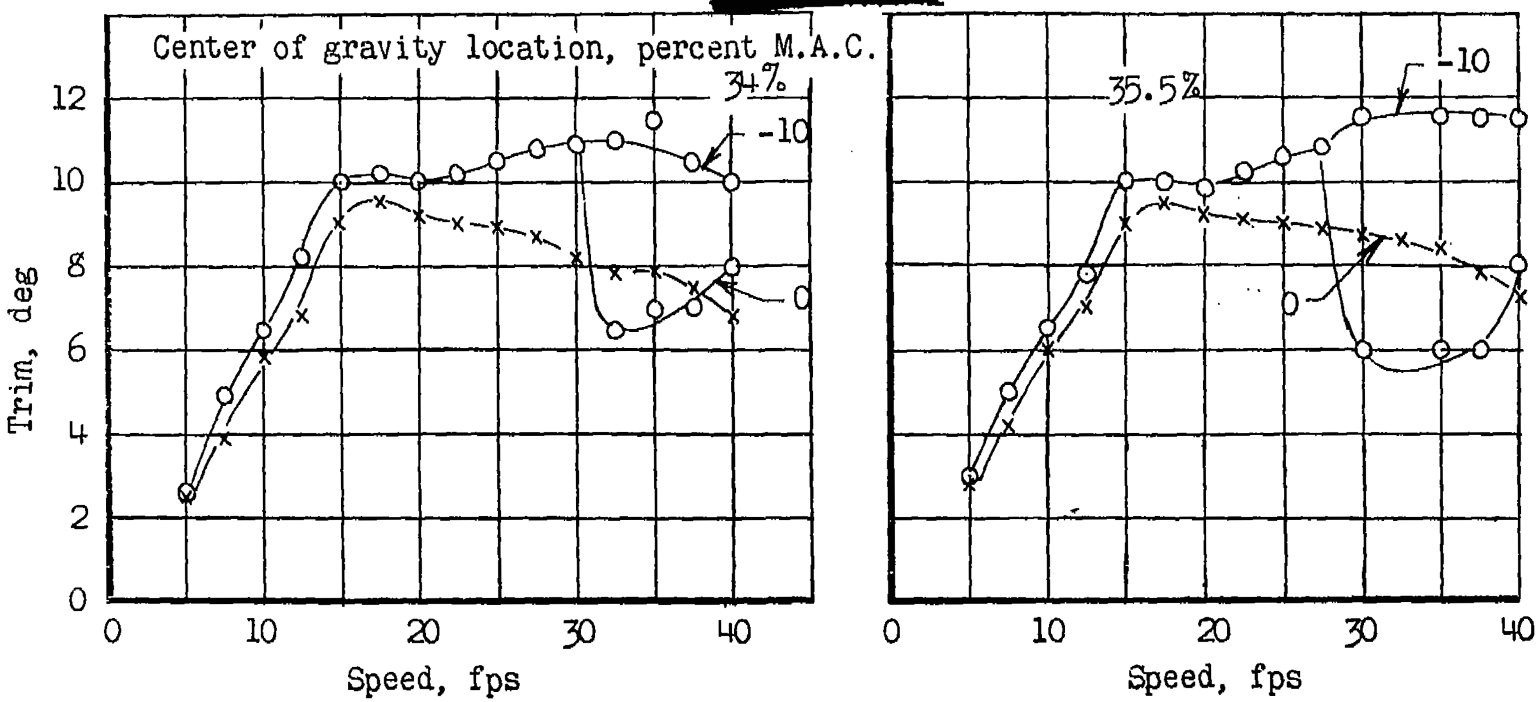
Figure 20.- Model 212. Effect of gross load on the limits of stable locations of the center of gravity. Full power; flaps, 20°. [redacted]



(a) Center of gravity locations 18 to 32 percent M.A.C.

Figure 21 .- Model 212. Variation of trim with speed. Gross load, 75.0 pounds (26,000 pounds full-size); full power; flaps, 0°.

[redacted]



(b) Center of gravity locations 34 and 35.5 percent M.A.C.

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Figure 21 .- Concluded.

[redacted]

[redacted]

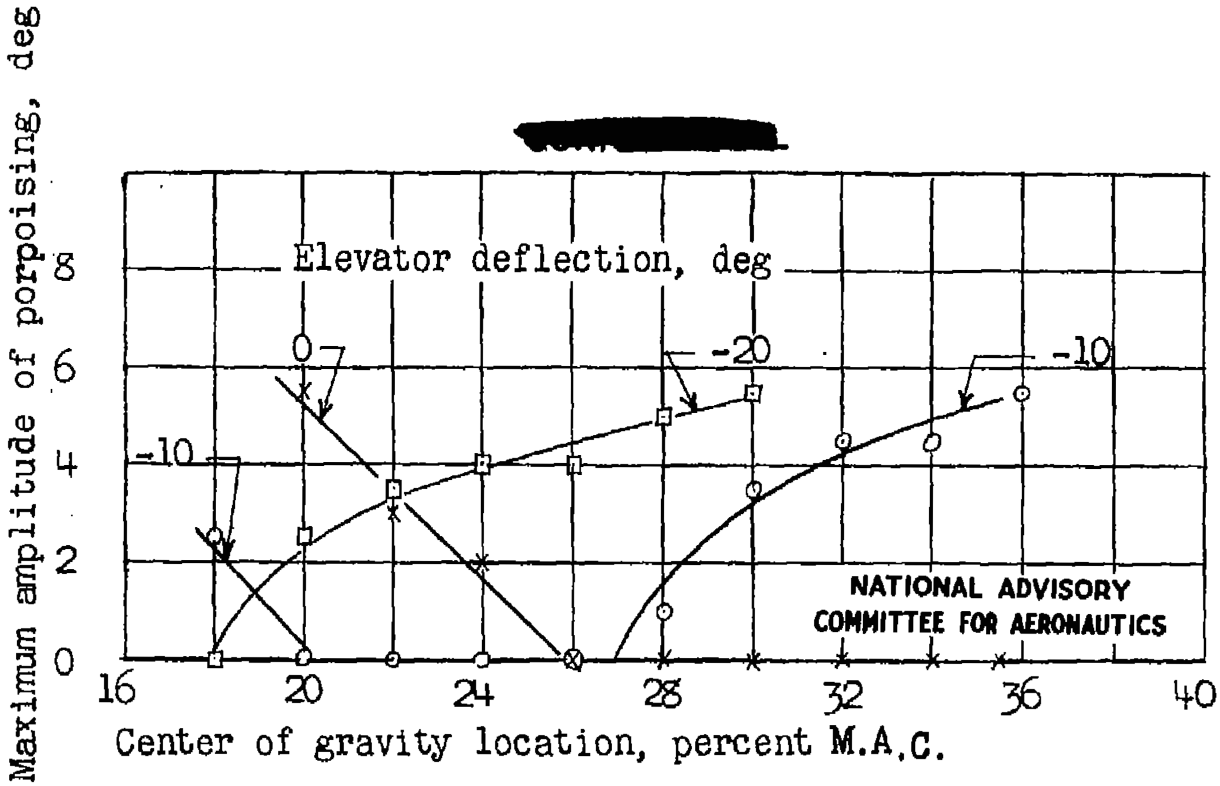

Figure 22 .- Model 212. Maximum amplitude of porpoising at several elevator deflections and locations of the center of gravity. Gross load, 75.0 pounds (26,000 pounds full-size); full power; flaps, 0°.

[redacted]

[redacted]

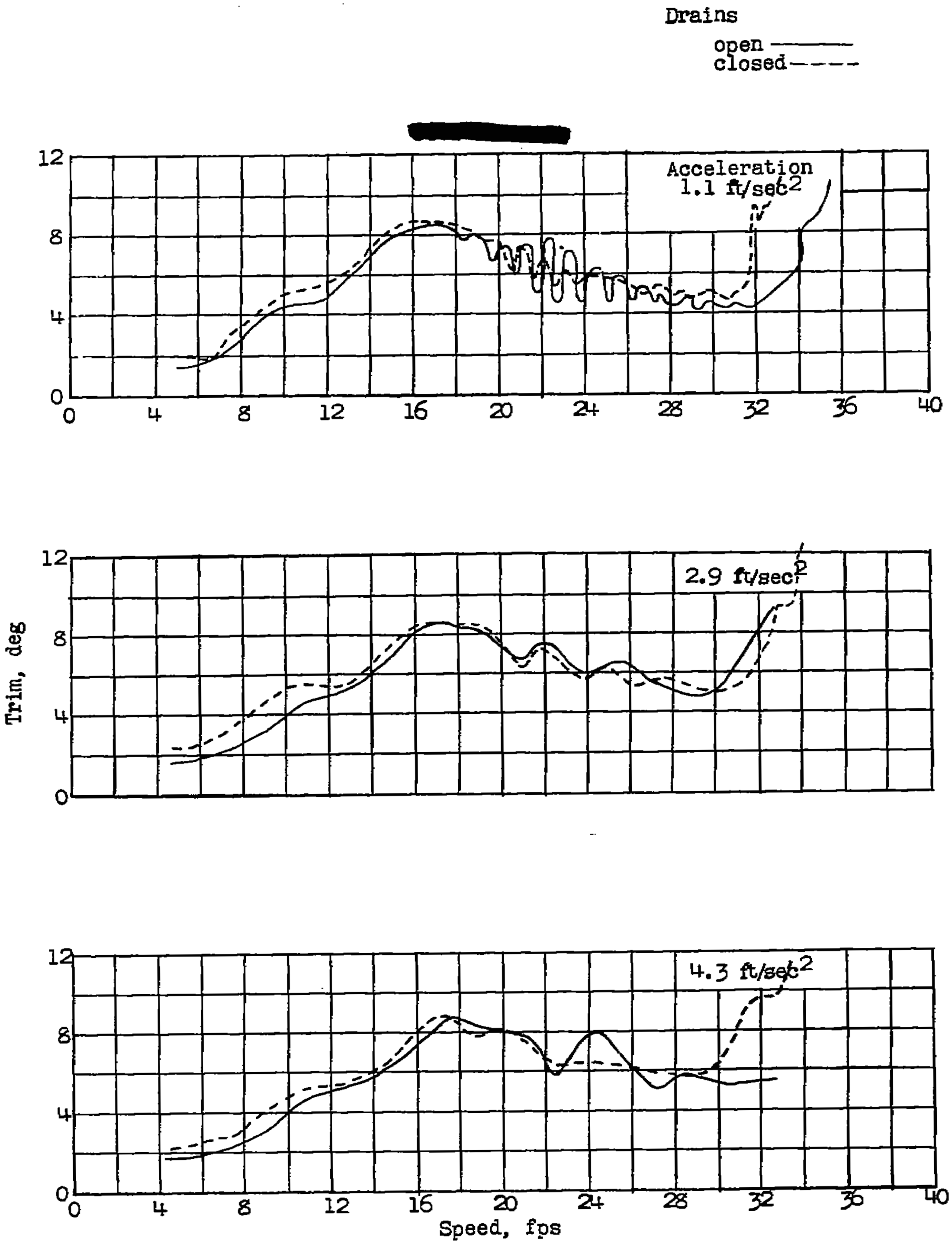

Figure 23.- Model 212. Effect of nose-wheel drains on trim tracks for several accelerations. Gross load 65.2 pounds; full power; center of gravity 30 percent M.A.C.; flaps, 20°; elevators, -30°.

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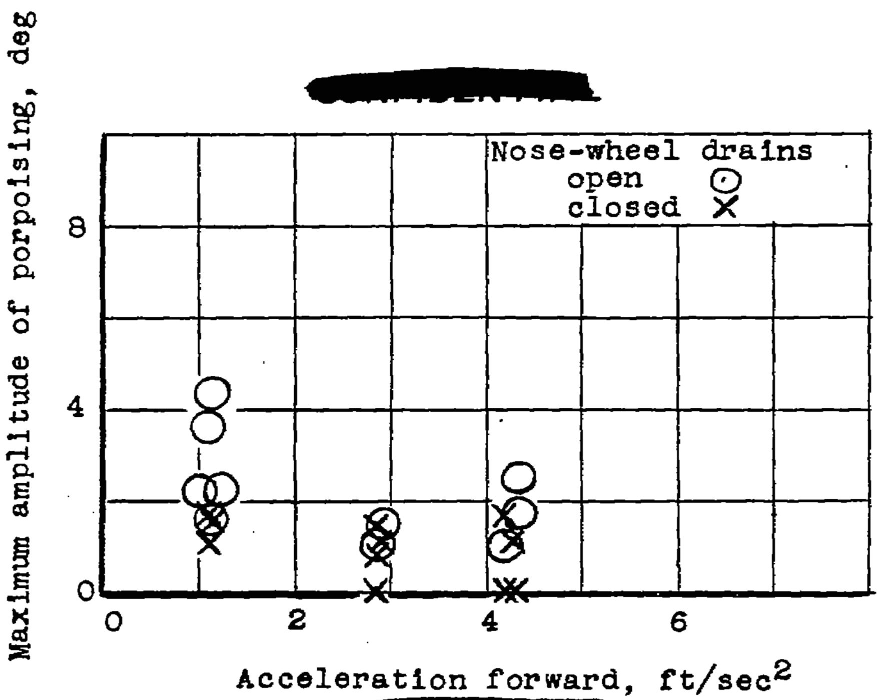

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Figure 24.- Effect of nose-wheel drains on maximum amplitude of porpoising for several accelerations. Gross load, 65.2 pounds; full power; center of gravity, 30-percent M.A.C.; flaps, 20°; elevators, -30°.